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New Chinese Training Cruiser Ying Swei

BY F. C. COLEMAN

The cruiser *Ying Swei* was built by Messrs. Vickers, Ltd., of Barrow-in-Furness; and although intended primarily for the training of officers for the Chinese naval service, the vessel possesses valuable properties of an offensive as well as defensive character, and should prove an acquisition to the sea forces of the Chinese Republic.

The principal dimensions are:

Length between perpendiculars.....	330 feet.
Breadth molded	39 feet 6 inches.

side of the vessel. The 4-inch guns are situated on each side of the upper deck at the break of the poop and forecastle, and have angles of training from the fore and aft line to 60 degrees before and abaft the beam, respectively. The 12-pounder and 3-pounder guns are situated along each side of the upper deck amidships, and have angles of training of from 60 degrees before to 60 degrees abaft the beam. The 1¼-pounder guns are placed on each side of the navigating bridge, and have angles of training of from 30 degrees across the bow to 30



A RECENT ACQUISITION TO THE NAVAL FORCES OF THE CHINESE REPUBLIC

Depth molded	23 feet 9 inches.
Mean draft	13 feet.
Displacement, approximate	2,460 tons.
Speed	20 knots.
Coal bunker capacity.....	600 tons.
Oil fuel capacity	55 tons.
Normal supply of coal.....	225 tons.

The armament of the *Ying Swei* consists of two 6-inch guns, four 4-inch guns, two 14-pounder guns, six 3-pounder guns, two 1¼-pounder guns, and two 18-inch deck torpedo tubes. The two 6-inch guns are situated on the forecastle and poop decks, and have arcs of training from the fore and aft line to 60 degrees abaft, or before the beam, respectively, on each

degrees abaft the beam. The torpedo tubes are situated on the upper deck aft of 'midship, and have angles of training of from 30 degrees before to 30 degrees abaft the beam. The gunfire is controlled from the forward bridge, and the torpedo tubes can be fired from the conning tower or at the tube. For the rapid delivery of the ammunition to the 6-inch and 4-inch guns electric bollard hoists have been introduced, the ammunition being protected on its way to the guns by steel tubes 1 inch in thickness.

An armored deck of varying thickness with sloping sides extending well below the normal waterline affords protection

to the magazines and other vital parts of the ship. The disposition of the coal has also been considered so as to afford the maximum protection from gun fire. A conning tower of 3-inch Krupp cemented armor is situated on the forecastle deck, and is fitted with all the usual and necessary appliances for the working and fighting of the vessel. A steel communication tube from the floor of this conning tower to the protective deck provides protection for the various leads of shafting, etc., passing from the conning tower to the interior of the vessel.

The ship is constructed throughout of steel and divided into numerous watertight compartments by watertight bulkheads and flats. The foremost bulkhead is specially strengthened to withstand an inrush of water from the sea. A double bottom extends for almost the entire length of the vessel, and is fitted with the usual appliances for dealing with the oil fuel, feed water and water ballast. Trimming tanks are provided at the ends of the ship, and there are also tanks for the storage of a large supply of fresh water.

There is accommodation for 230 officers and men and for forty cadets. The quarters for the captain and chief officers are under the poop deck, and for the remainder of the officers and cadets under the upper deck aft. The crew are berthed forward under the forecastle and upper decks. Sick bay, dispensary, school room and the usual bath and lavatory accommodation are provided for the officers and crew. The magazines and shell rooms, steering gear and capstan engine are placed under the protective deck, and there is ample storage room in the hold and elsewhere.

A refrigerating plant is installed in connection with the cold storage arrangements and also for maintaining a low, even temperature in the magazines. The pumping, flooding, draining and ventilating systems are in accordance with the most approved practice, the ventilation system being made to suit the varying climate conditions obtaining along the sea coast of China. The *Ying Swei* is fitted throughout with a complete installation of electric lighting and power with two generating sets, each capable under ordinary conditions of supplying the electricity necessary for the ship. Two 24-inch searchlights of standard type, one forward and one aft, are fitted on specially constructed platforms, and there is a complete range-finding equipment on the compass platform forward.

The number of boats carried is similar to that provided for vessels of the same class in other navies, and includes a steam launch having a speed of 8 knots.

The propelling machinery is of the Parsons turbine type, having three lines of shafting, with one propeller on each shaft. The turbines, arranged in one engine room, comprise one high-pressure ahead turbine on the center shaft and one low-pressure ahead on each wing shaft. The wing shafts are arranged for working astern, a reversing turbine being incorporated in each of the two low-pressure turbine casings. In addition to the main steam connections to the high-pressure ahead turbine, there are separate steam connections with regulating valves fitted to each of the low-pressure ahead and astern turbines. For economical working at low speeds a cruising element is fitted in the high-pressure end of the high-pressure turbine. All the turbine bearings and shaft bearings are arranged for forced lubrication, pumps being supplied for this purpose together with an oil cooler and tanks, etc.

The main air pumps are independent direct acting, one for each condenser. The condensers are arranged in the wings of the ship, and they are cylindrical in form with the casings built up of steel plates and angles with conical ends of gunmetal. The circulating water is supplied by two centrifugal pumps, driven by independent single-cylinder engines, the pumps being also arranged to draw from the bilges.

The shafting throughout is made of forged steel and the various lengths are filleted into one another. The propellers

are three-bladed, the bosses and blades being cast solid of manganese bronze. The wing propellers are arranged to work outwards when going ahead.

The distilling and evaporating machinery is of ample capacity, two evaporators, capable of supplying 35 tons of water per 24 hours and one distilling condenser capable of condensing all the steam from the evaporators, are fitted. The evaporators work under the closed exhaust system, the steam pressure in the generating coils being 25 pounds per square inch, taken from the auxiliary exhaust system or the auxiliary steam service.

There are six boilers, including watertube, cylindrical boilers and generators of the White-Forster type, the latter being arranged to burn oil fuel as well as coal. The watertube boilers are four in number, and they are capable of producing steam for about two-thirds of the total horsepower, and the cylindrical boilers are of the single-ended return tube type, designed to work under the forced draft, closed stokehold system. The total heating surface is 12,900 square feet and the total grate area is 287 square feet. Air is supplied to the stokehold by six steam-driven fans of the double inlet type, the engines being of the enclosed type fitted with forced lubrication. The feed water is supplied to the boilers by four feed pumps of Weir's direct-acting type.

The results attained during the official speed and other trials of the *Ying Swei* are shown in the table:

	24 Hours' Trial. Mean Result of Whole Trial.	On Measured Mile.	Full Power Trial. On Measured Mile.	Two Hours, Oil Fuel with Cylindrical Boilers Only.
Shaft horsepower	1,100	1,278	6,375	2,088
Mean revolutions, three shafts.	311	330.6	556.5	396
Speed on revolutions	12.3	.....	.....	15.8
Speed on miles .....	.....	13.14	21.21	.....
Coal consumption, pounds per horsepower per hour...	2.6	.....	.....	.....

FIRST SHIP BUILT ON MANHATTAN ISLAND.—Just 300 years ago, in 1613, occurred the first shipwreck in New York Bay, and the same year saw the building of the first ship ever built by white men on Manhattan Island, says a recent writer. A company of merchants in Amsterdam sent out five vessels loaded with goods to be traded with the Indians in America. Among the skippers of the vessels was Adrian Block, commanding the *Tiger*. Some time in the latter part of 1613 the *Tiger* caught fire and was completely destroyed. The captain and crew immediately started to build a new vessel, and it was finished and launched early in the following spring. The ship is generally supposed to have been built on the site of what is now Fraunces Tavern.

MARINE FREIGHT TERMINALS IN MINNESOTA.—The State of Minnesota evidently appreciates the necessity of having steamboat landings and the handling of freight at them under the control of local authorities, with power to control such facilities. A law has just been enacted giving Minnesota cities the power to acquire lands and construct, maintain and create docks, wharves, levees and other terminal and storage facilities along and adjacent to the Mississippi River and other navigable waters, and to issue bonds to pay for such facilities and improvements.

SHIPPING IN THE PHILIPPINES.—Vessels from foreign ports entering Manila Bay during 1912 numbered 811, representing a total of 1,779,635 net tons. The port of Manila is dredged to a depth of 30 feet, and has two piers 550 by 75 feet and 650 by 110 feet, respectively, with another planned to be 750 by 160 feet.

Mechanical Gearing for Propulsion of Ships*

BY THE HON. SIR CHARLES A. PARSONS, K. C. B., D. Sc., F. R. S.

The subject of the application of steam turbines with mechanical gearing to ship propulsion has already been brought before the notice of this institution in papers read by the author in 1910 and 1911. These papers described the experimental installation in the cargo steamer *Vespasian*, the successful results obtained with which have since that time led to considerable development in this type of propulsion. It is the object of the present paper to give an account of the progress that has been made up to the present time.

Geared turbine propulsion is in this country now well advanced beyond the experimental stage. There are already in

propellers with the lower revolutions adopted, and partly to improved form of vessel incidental to the reduction in boilers and the adoption of twin screws. The *Normannia's* gearing has been recently inspected after steaming over 26,000 knots, and was found to be in perfect condition; no wear whatever can be detected.

Geared turbines have also been installed in three Channel steamers for the Indian Ferry service between India and Ceylon, in accordance with designs and specifications prepared by Sir William White. The first of these, the *Curzon*, has successfully passed her speed trials, and considerably exceeded

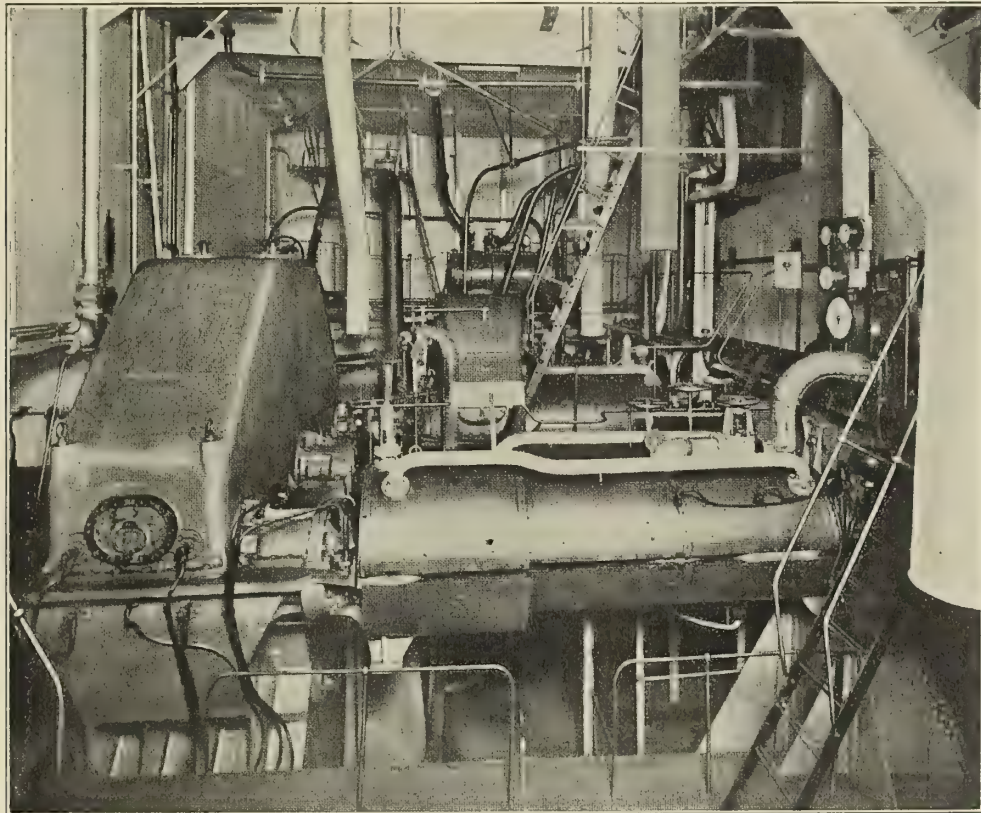


FIG. 1.—ENGINE ROOM OF STEAMSHIP CAIRNROSS

actual service cargo steamers, Channel steamers and warships, together representing a total of about 26,000 horsepower, developed by steam turbines and transmitted through mechanical gearing, and there is at the present time under construction turbine machinery and mechanical gearing representing a transmission of over 120,000 horsepower, including two installations of over 20,000 horsepower each.

Geared turbines have been fitted in two Channel steamers for the London & South-Western Railway Company's service between Southampton and Havre, the steamships *Normannia* and *Hantonia*, of 1,900 tons displacement, having a shaft-horsepower of 5,000 at a service speed of about 18 knots. These installations were fully described in a paper read before this institution by Prof. J. H. Biles in 1912. They continue to show an economy, as compared with other turbine steamers on the same service, of about 40 percent, due partly to increased efficiency of turbines, partly to increased efficiency of

the speed guarantee undertaken by the builders of the vessels and propelling machinery, Messrs. Inglis & Company, Glasgow. The reduction gear was made by the Parsons Marine Steam Turbine Company.

A cargo steamer built for the Cairn Line by Messrs. Doxford, Sunderland, has been recently fitted with an installation of geared turbines (Fig. 1) similar to that adopted in the *Vespasian*, consisting of two turbines, a high-pressure and a low-pressure turbine in series, capable of developing about 1,600 shaft-horsepower, which is transmitted through mechanical gearing to a single propeller shaft at 63 revolutions per minute, the speed of the vessel being about 10½ knots. It is interesting to notice that a coal consumption trial has been made this ship running side by side with a sister ship, the *Cairngowan*, with exactly similar boilers and propeller, but with triple-expansion reciprocating engines, the coal supplied being of the same quality and measured in the same way on both ships, and the geared turbine ship has shown a saving of 15 percent in the coal consumption.

* Abstract of a paper read before the Institution of Naval Architects, London, March, 1913.

So far no limit in regard to the surface speed of the teeth has been discerned, and there is no evidence of any limit to the power that can be transmitted by mechanical gearing with gear wheels suitably designed. It appears that this type of propulsion can be adopted with advantage in all classes of work ranging from low-speed cargo steamers to high-speed destroyers and battleships and liners of large powers, and

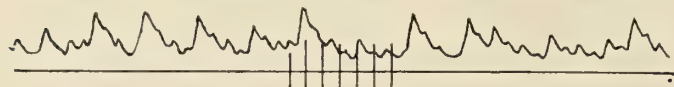


FIG. 2

there can be little doubt that it will be extensively employed for all classes of ships in the near future.

A few illustrations are given at the end of the paper of typical arrangements of geared turbine machinery.

Fig. 3 shows an installation of geared turbine machinery suitable for a cruiser of about 30,000 horsepower on two shafts at 300 revolutions per minute.

Fig. 4 shows an installation suitable for a destroyer of about 20,000 horsepower, with twin screws at 440 revolutions per minute. It will be seen that the installation consists of a high-pressure and a low-pressure turbine driving each shaft, and an additional cruising turbine geared with one of the shafts for employment at low speeds.

Fig. 5 illustrates a design for a battleship of about 40,000 horsepower, with four shafts at 200 revolutions per minute. In the arrangement illustrated there are two turbines geared to each shaft, the turbines on the two shafts on either side of

range the gear wheels of the cruising set would be connected to the propeller shafts through clutches, and the main gear wheels also clutch-connected, so that whichever set of machinery was in use the other set could be entirely disconnected from the propeller shafts, and all losses from idle running avoided. This separate cruising installation would have its own small condensing plant, or could make use of the small

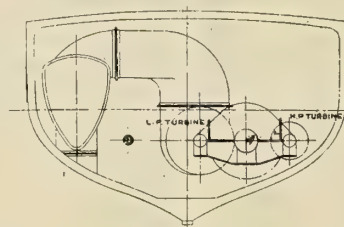
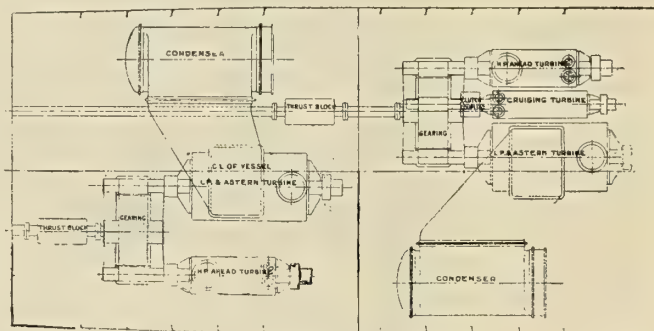
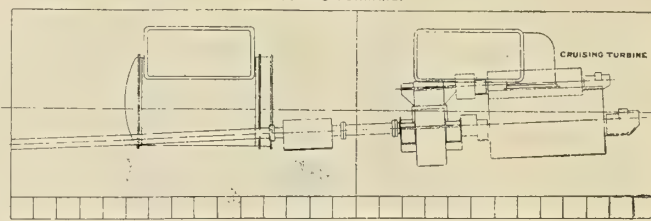
SECTION AT A-A
LOOKING FORWARD.

FIG. 4.—TYPICAL DESTROYER INSTALLATION

auxiliary condensing plant usually fitted. By this means the fuel consumption per shaft-horsepower at the cruising speed can be made practically the same as that at full power.

For the purpose of observing, as closely as possible the practical requirements in regard to accuracy of cutting of gear wheel teeth, two gear-cutting machines were installed in the works of the Parsons Marine Steam Turbine Company in 1910. With these machines, which were built by Messrs. William Muir & Company, Manchester, tooth faces are automatically generated by the process known as "hobbing." These two machines have, since they were installed, cut gear wheels representing a transmission of about 50,000 horsepower, and the experience thus gained in this work has enabled several important improvements to be made to them.

Two similar machines were installed in the works of Messrs. C. A. Parsons & Company, Heaton, Newcastle-on-Tyne, for the manufacture of geared plant for the driving of electrical generators, rolling mills, work shafting, etc.

Examination of the teeth of gear wheels which have been running for some little time, transmitting large powers, shows the work to be distributed over the teeth with fair uniformity, and confirms the opinion expressed by the author before this institution in 1910 in his reply to the discussion on the first of the papers above referred to, that with double helical gear such devices as floating frames for the pinions or hydraulic pistons to distribute the load equally over the pinion bearings are totally unnecessary, the natural elasticity of the supporting

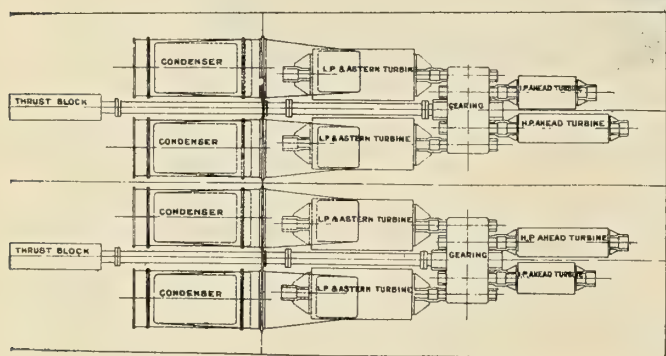
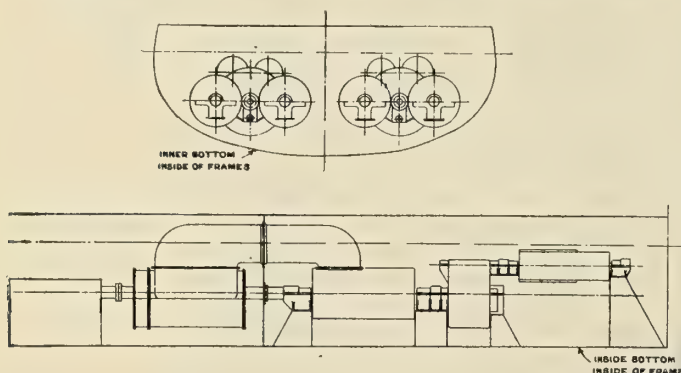


FIG. 3.—TYPICAL CRUISER INSTALLATION

the ship being arranged in the well-known four-cylinder triple formation, each group consisting of a high-pressure, an intermediate-pressure and two low-pressure turbines, an arrangement which leads to a high efficiency both at full power and at cruising speeds.

Fig. 6 shows a further design for a battleship of about 60,000 shaft-horsepower, with geared turbine machinery on four shafts, which also includes an additional set of small turbines and gearing for use when cruising. In such an ar-

structures providing all the accommodation necessary, assuming, of course, reasonably accurate alinement of the shafts. The pinions are in all cases connected to their turbine shafts by flexible couplings, which allow them longitudinal freedom, and this in itself, with double helical gears, ensures that the load is practically equally divided between the right and left-hand portions of the gear.

Careful investigations have been made of the causes producing noise, with the object of removing such causes and obtaining a silent gear. These investigations show the noise to be

permitting a movement of about $1/100$ inch as the load was increased to its full value. The pinions being thus flexibly supported, noise and shock were to some considerable extent intercepted, instead of being transmitted to the structure of the gear case.

It was recognized, however, that spring supports were an imperfect remedy, the real remedy being a higher degree of accuracy in the teeth. To attain this it was necessary either to greatly increase the accuracy of the parent gear or to devise means of cutting which did not reproduce the errors of the

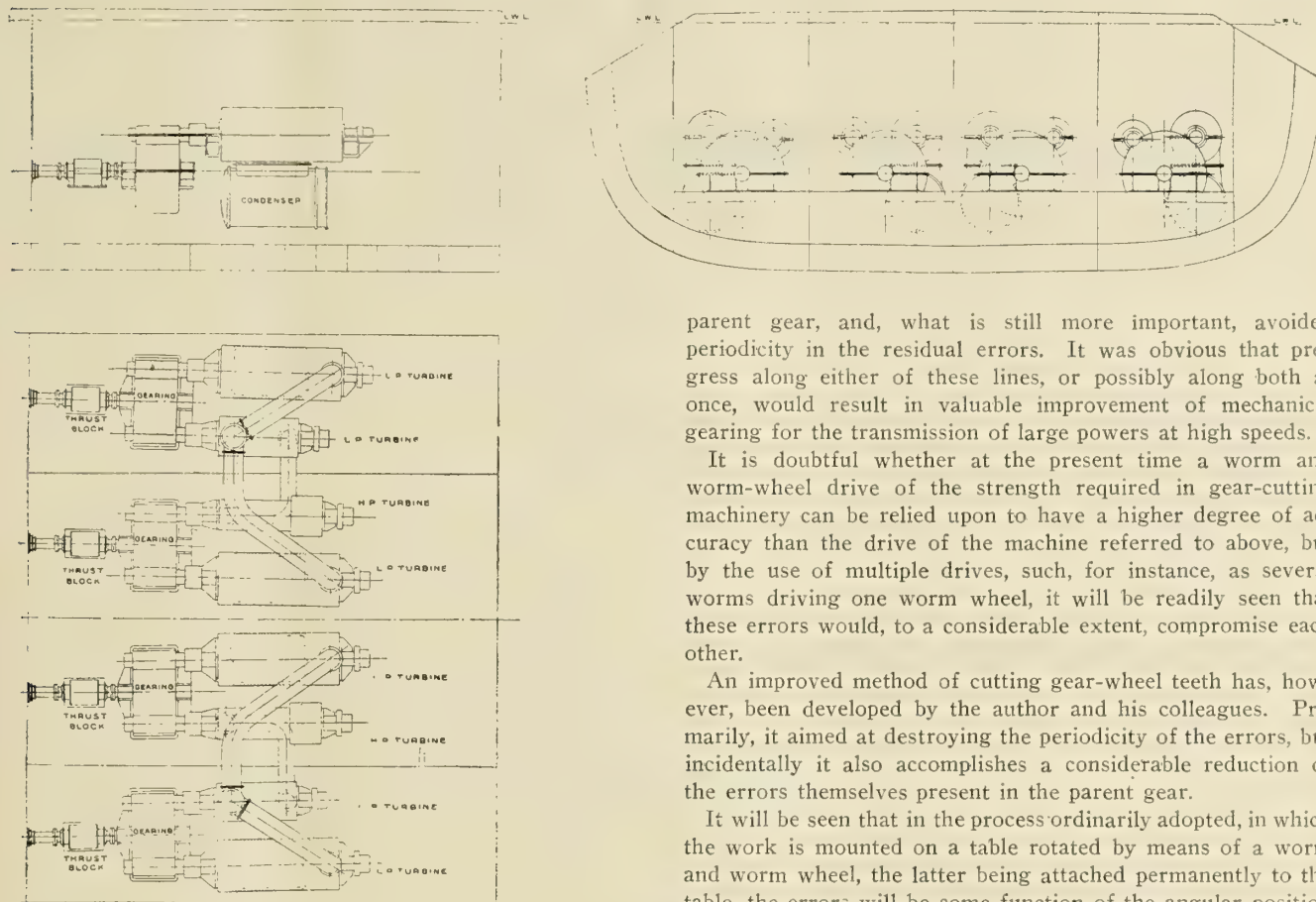


FIG. 5.—BATTLESHIP INSTALLATION

due to slight inaccuracies in the teeth, the order of accuracy required for silent gearing being higher than present gear cutting machines are capable of affording. Fig. 2 is reproduced from a photograph of a microphone oscillograph record obtained from a double helical gear wheel by suspending over the gear case a microphone connected with an oscillograph. It will be observed that definite notes are produced. In the particular case illustrated the frequency was found to be 160 times the number of revolutions of the wheel, and its source was traced to the parent gear of the gear-cutting machine, viz., the single worm and the 160 teeth of the worm wheel which rotated the table on which the work was mounted while the wheel was being cut. The inaccuracies of this gear were carefully measured, and found to be co-periodic with the worm wheel teeth, and to have a double amplitude of about four-thousandths of an inch.

In the case of the gear wheel referred to above, as there did not appear at the time to be any means of removing the irregularities from the teeth, and very silent running was desired in this instance, stiff springs were fitted above and below the bearings, having a small amount of initial compression and

parent gear, and, what is still more important, avoided periodicity in the residual errors. It was obvious that progress along either of these lines, or possibly along both at once, would result in valuable improvement of mechanical gearing for the transmission of large powers at high speeds.

It is doubtful whether at the present time a worm and worm-wheel drive of the strength required in gear-cutting machinery can be relied upon to have a higher degree of accuracy than the drive of the machine referred to above, but by the use of multiple drives, such, for instance, as several worms driving one worm wheel, it will be readily seen that these errors would, to a considerable extent, compromise each other.

An improved method of cutting gear-wheel teeth has, however, been developed by the author and his colleagues. Primarily, it aimed at destroying the periodicity of the errors, but incidentally it also accomplishes a considerable reduction of the errors themselves present in the parent gear.

It will be seen that in the process ordinarily adopted, in which the work is mounted on a table rotated by means of a worm and worm wheel, the latter being attached permanently to the table, the errors will be some function of the angular position of the work, and therefore lie in planes through the axis of rotation; and if, as is mostly the case, the errors of the parent gear are periodic, these planes will lie at equal angular intervals, and will come into mesh periodically. Now, it will be seen that if the work is given a small, steady advance in relation to the table, the errors, instead of lying in planes through the axis, will lie in spirals around the wheel, and that when put to work they will be obliterated and leave a true wheel.

In the adaptation of this new principle of cutting to an existing gear hobbing machine, a secondary table is mounted on the original table of the machine, and given a creep in advance of 1 percent in relation to it by means of a train of gearing, the main worm driving the lower table being driven at 1 percent less speed, so as to secure the same rotational speed as before the creep was introduced.

While the most important effect of this arrangement is that the errors in the teeth will lie in very oblique spirals around the wheel, resulting in great uniformity in the gearing, at the same time it has also an important effect in reducing the errors themselves. In fact, three things have been accomplished. In the first place the errors have been reduced to about one-fifth of their original magnitude; secondly, they are spread

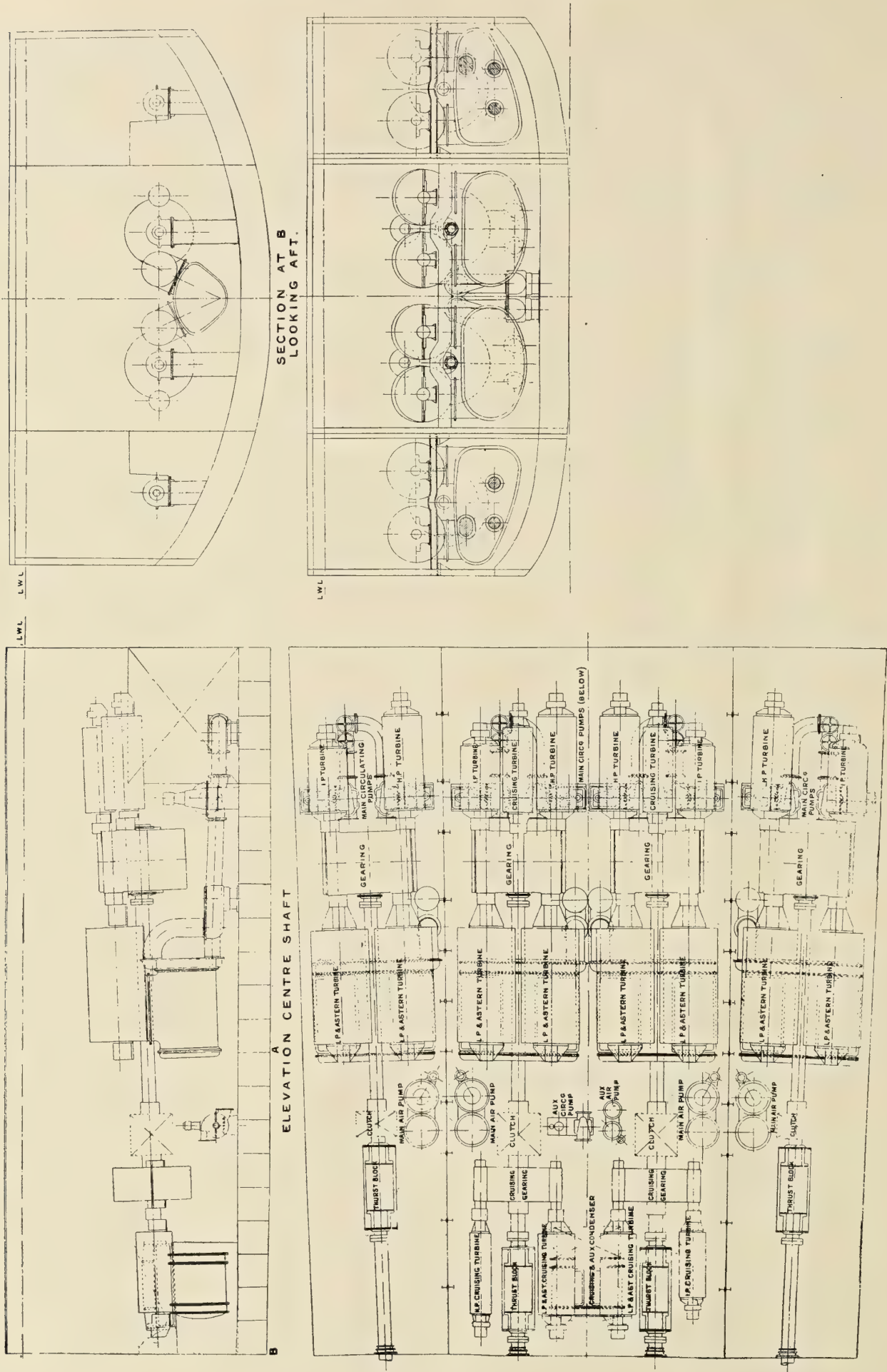


FIG. 6.—BATTLESHIP INSTALLATION, WITH SEPARATE CRUISING TURBINES

across the wheel in such a way that periodicity is avoided, and, thirdly, they consist of cuspidal ridges which will be easily reduced by grinding or wear and leave a practically true wheel.

Anti-Destroyer Guns

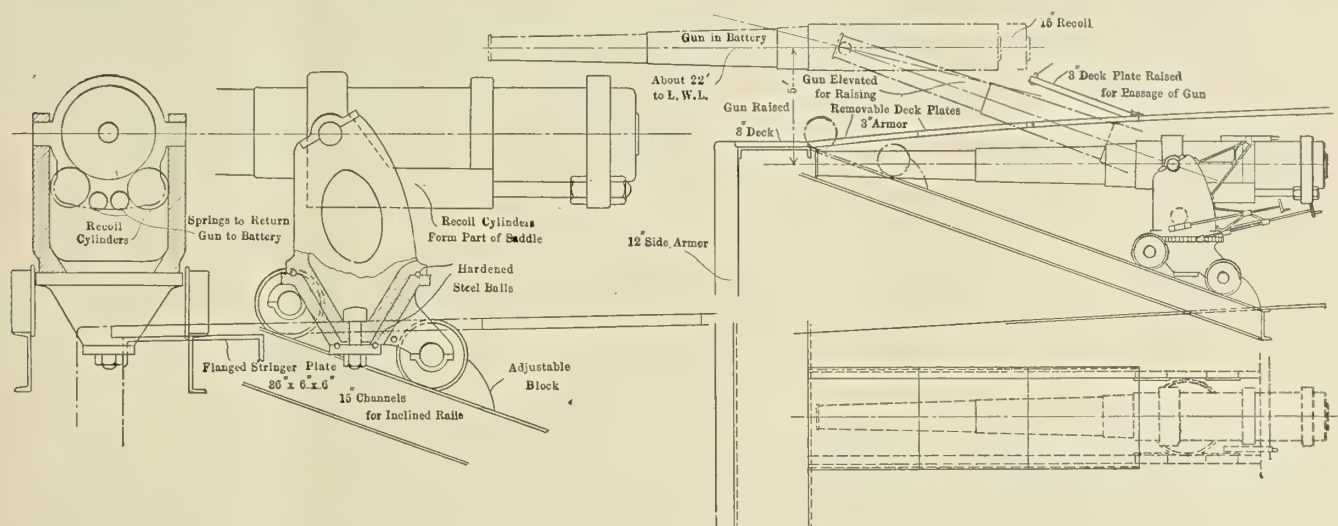
BY SIDNEY GRAVES KOON, M. M. E.

Ever since the torpedo boat first cast its menace across the waters, measures have been taken looking to destroy it before it could get within striking distance. Rapid-fire guns, throwing a score of shots per minute, have been developed, until the sides of some ships fairly bristle with them. The Russian *Tri Sviatitelia*, launched in 1893, has fifty-two rapid-fire guns of 1-pounder and 3-pounder size. The *Oslabya* (1898) had forty-six. On the *Kniaz Suvaroff* (1902), Rozhdestvensky's flagship, sunk at the battle of the Sea of Japan, were forty-eight, of which twenty were 12-pounders—the balance 3-pounders and 1-pounders. The increasing size was due to

guns, as noted, but also the conserving of the power in those guns until the time when, after the artillery duel, the destroyer attack is loosed.

But in all designs as yet made public, the anti-torpedo battery is undeniably susceptible to being put out of commission by the fire of the opposing primary guns, especially if the combat is at all prolonged. Their armor protection is too light to withstand the attack of these heavier pieces, and the long, slender chases of the guns themselves, protruding 12 or 15 feet from their ports, seem actually to invite disaster. Any combatant, strong in destroyers, would be sure to devote especial attention to attacking these light guns, with the idea of being able to deliver his coup-de-grace with the destroyers as soon as the enemy should be deprived of his best defense against them.

For this reason it is becoming ever more imperative to install the guns under such conditions as to make certain their being usable even after a long, stubborn conflict. They should be so disposed and so protected that no hostile torpedo craft could approach from any angle, even after the battle, without meeting a storm of shell from them—a storm which would



DETAILS OF PROPOSED MOUNTING FOR ANTI-DESTROYER GUNS

increasing ranges at which torpedoes were being discharged effectively.

The United States navy used 6-pounders for this work long after England had substituted 12-pounders. This may have been due, at least in part, to the difference in power of the fleets of torpedo craft being developed in Europe and in America, respectively. Then the American 14-pounder persisted until we find it in the first two dreadnoughts. It has now been replaced everywhere by the 5-inch piece, throwing a 50-pound projectile.

England adopted the 4-inch, 31-pounder, after the first *Dreadnought*, and has now jumped to the 6-inch, 100-pounder. Germany uses the 5.9-inch and 6.7-inch associated with the 3.4-inch, 24-pounder. Japan uses the 6-inch and 4.7-inch, 45-pounder, in the same ship. France has come to the 5.5-inch after long clinging to the 9-pounder (the 14-pounder was mounted on six ships only).

In practically every case the guns under 5 inches are without armor protection. With the advent of the heavier, costlier and more destructive anti-torpedo weapon has come a disposition to protect it. In many of the latest designs these guns will be found behind armor from 6 inches to as much as 9 inches in thickness. It is realized more and more that, with the increasing destructiveness of the under-water projectile, a more positive means must be adopted of keeping its carriers at a respectful distance. This has meant not only the heavier

search out its vitals before it could come within the 4 miles now considered effective modern torpedo range. Hence the appeal of the design herewith submitted, which has been worked out in connection with that of a very powerful battle-ship of unusual size.

It is proposed to mount each gun carriage upon four wheels, running upon rails having an inclination or "grade" of about 20 degrees. At all times when not in use the gun reposes comfortably back of the 12-inch upper-side armor and beneath a 3-inch deck. Here it is unusually secure during the artillery stages of the battle, and until it is needed to repel the lighter but in many respects more dangerous assault. No chase projects to be shot off or cracked or to transmit to the carriage the energy of impact of a half-ton shell. All is completely under cover until called upon for action.

Then the manual removal of two 2,475-pound deck plates, the raising of a third about its hinges, and the elevation of the gun muzzle through 20 degrees, permit the weapon to be drawn forth from its retreat, and to assume its station on the broadside, clear of all the encumbrance of a narrow, constricted port, and having a clean sweep through a wide arc from its position 22 feet above the water. The hinged deck plate is lowered, and one of the others put back in place, thus leaving an unbroken deck from which to operate the gun. The raising of the gun itself through a vertical 5 feet, while it is run forward about 14 feet, is accomplished by four men with

a triplex hoist attached under the flanged stringer plate, and should consume less than one minute.

With the gun carriage securely held in position by the adjustable block back of the rear wheel, as well as by a clamping device holding it to the rails on either side, its two sets of hardened steel balls in steel races give it a free movement in training, and enable it to be brought to bear on any object within the arc over which it can swing without fouling the next (similar) gun on either side. The gun barrel recoils in its sleeve against the resistance of two hydraulic cylinders (water and glycerine) and two heavy springs. The springs

return it to battery. Training and elevating gear are at the hands of the gun pointer, whose telescope is attached to the carriage, and hence does not recoil or follow the gun's elevation.

The space required below decks for this gun is no greater than for a gun mounted in the usual way, even though it does carry its whole $21\frac{1}{2}$ feet well within the hull lines. But it is located in a narrow well, so to speak, and thus uses a minimum of fore-and-aft space. The weights involved, aside from the rails, are about as before. Simplicity is the keynote of the design, and reliability and absolute security its whole *raison d'être*.

German-Built Motor Ship Hermann Krabb

BY DR. ALFRED GRADENWITZ

The German Navigation Company Teutonia, of Montevideo, which has recently been founded as a branch of the Hamburg firm of Messrs. Hermann Krabb & Company, is intended to insure traffic throughout the course of the river La Plata. Among the vessels taken into use by this company, the motor ship *Hermann Krabb* is by far the most remarkable. This vessel has been built at the yards of Messrs. Stocks & Kolbe, of Kiel-Weddingdorf, and is equipped with two marine Diesel engines on the Hesselman system, manufactured at the shops of Messrs. Benz & Company, of Mannheim. The *Hermann*

Krabb, therefore, can be described as the first motor ship of German origin intended for a foreign country.

The hull has been built in accordance with the requirements of the service from first-class materials, its main dimensions being:

Length over deck.....	189 feet.
Length between perpendiculars.....	182.2 feet.
Breadth of frames.....	30.4 feet.
Molded depth.....	9.2 feet.
Draft	6.6 feet.

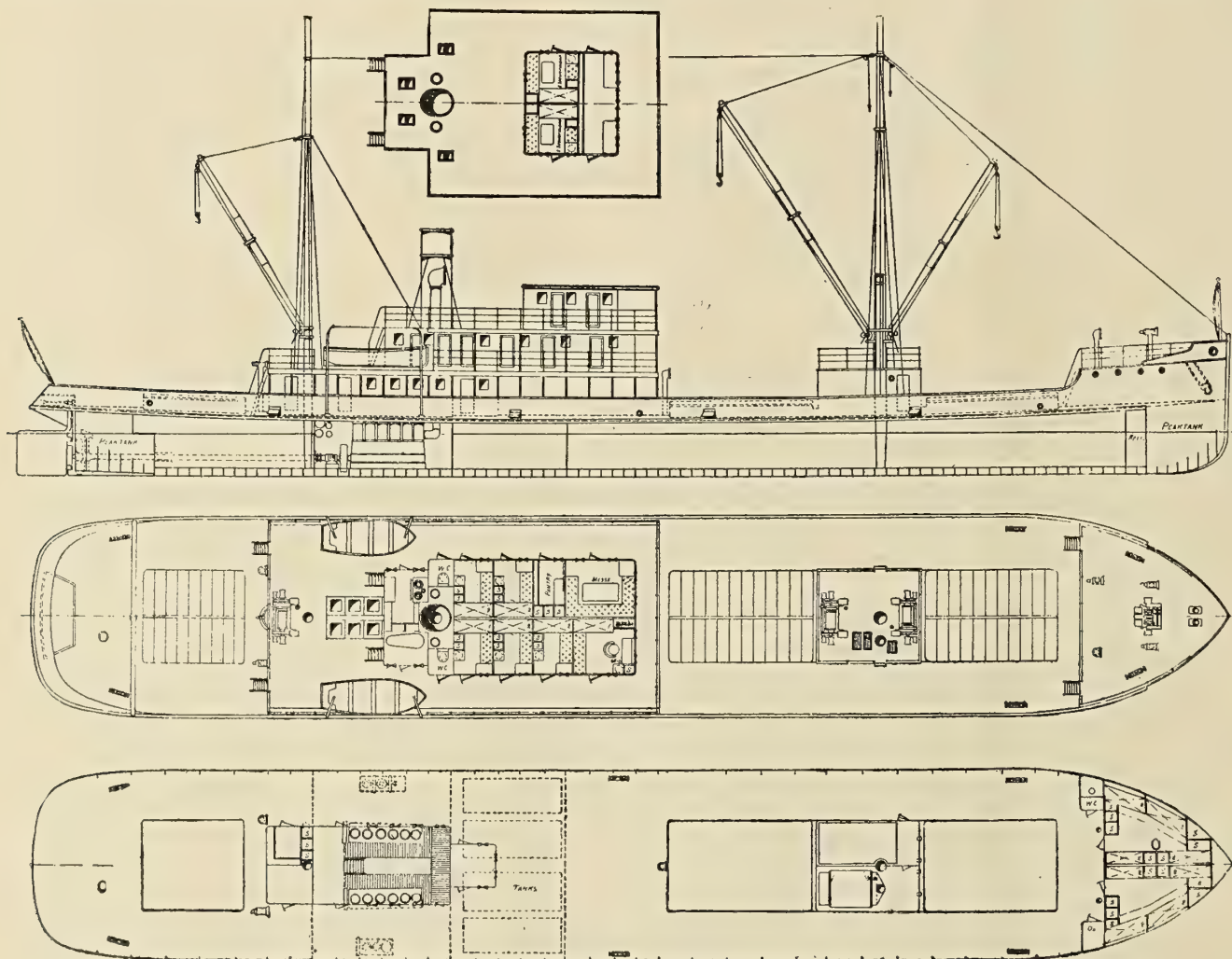


FIG. 1.—PROFILE AND DECK PLANS OF MOTOR SHIP HERMANN KRABB

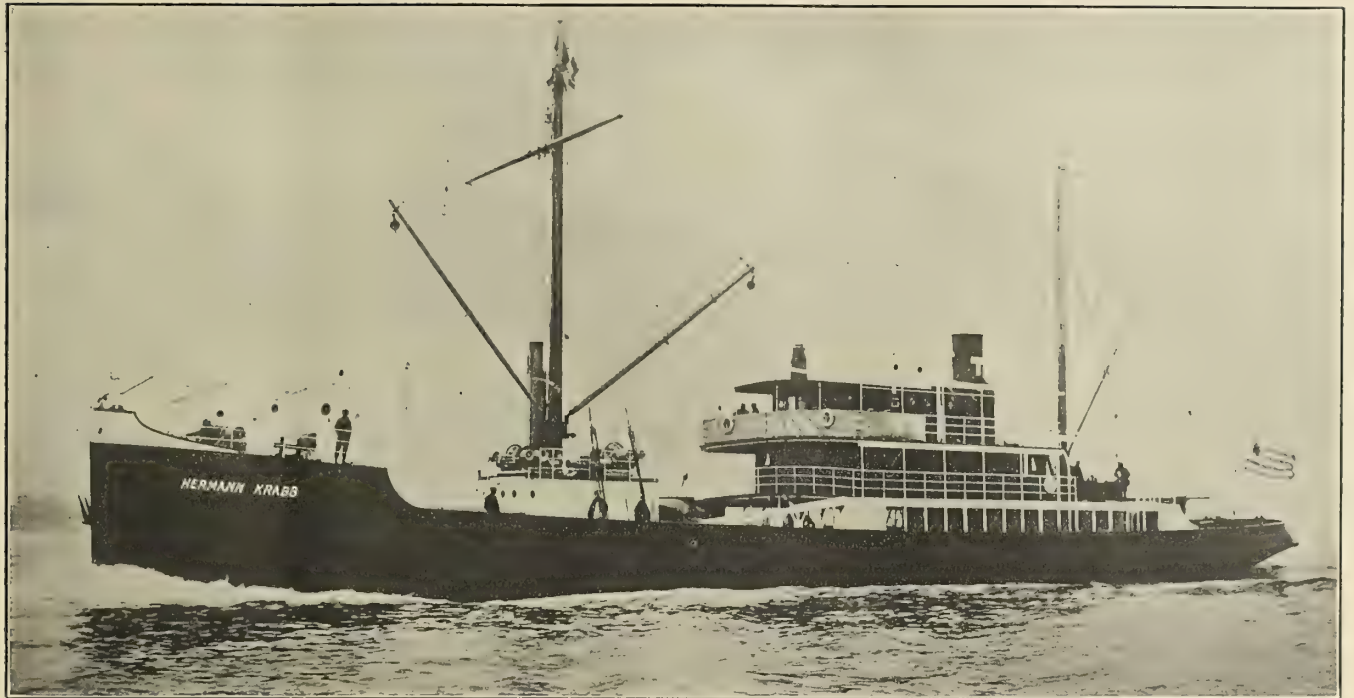


FIG. 2.—THE FIRST MOTOR SHIP BUILT IN GERMANY FOR A FOREIGN COUNTRY

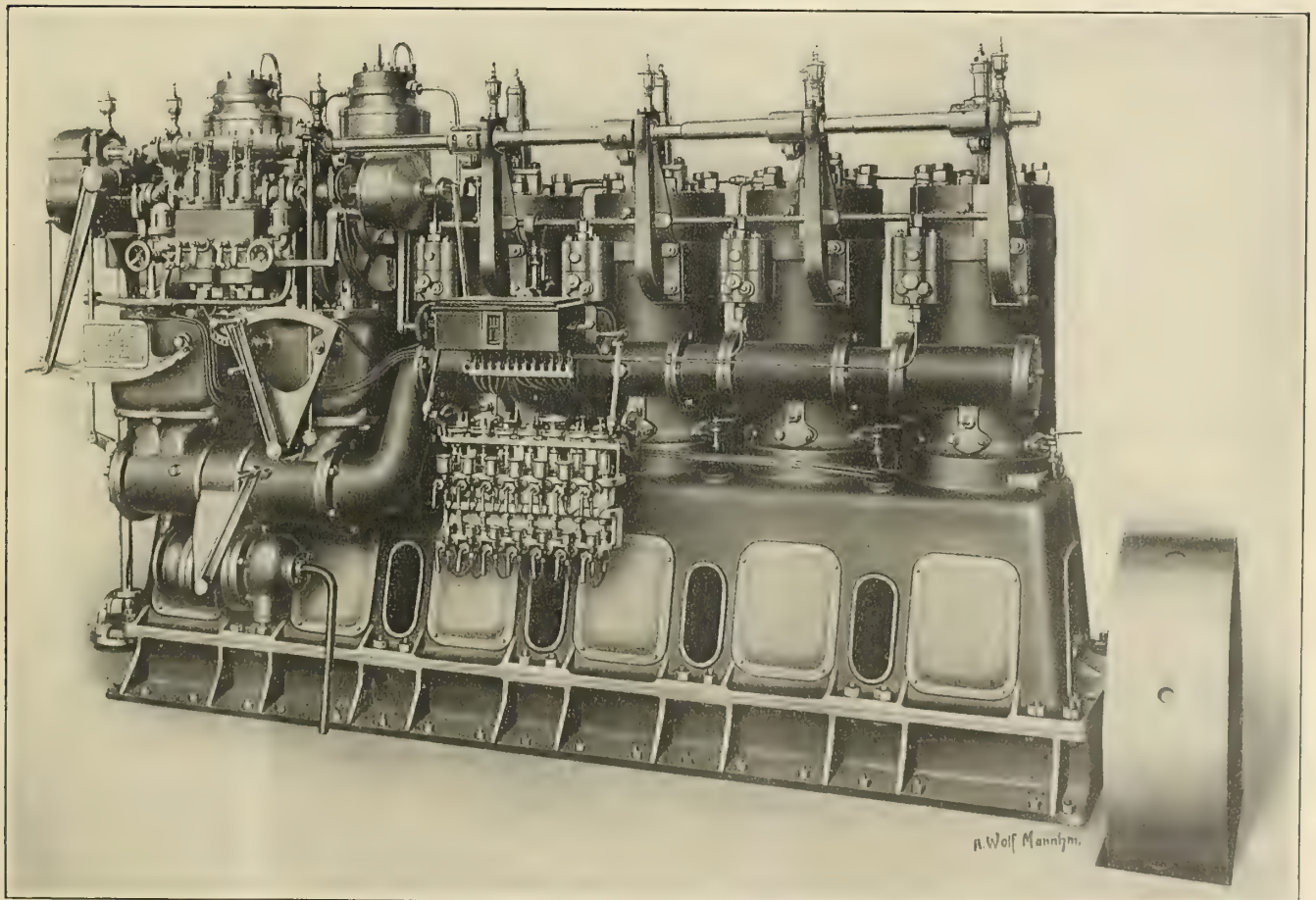


FIG. 3.—DIESEL ENGINE OF THE HESSELMAN TYPE FOR THE HERMANN KRABB

With a draft of 6.6 feet the loading capacity is 400 tons, apart from a store of 65 tons carried in the fuel tanks. This small draft enables the vessel, even on shallow river sections, to penetrate farther into the interior than a steamer.

The load is installed in a large hold in the fore part of the vessel, which is accessible through two hatches, and a small hold with one hatch behind the engine plant. Above the holds there are hoists equipped with all necessary derricks of 3 and 5 tons capacity. All loading winches are operated by steam generated by a donkey boiler, hand operation being provided for cases of emergency. Below the fo'castle there are rooms for the sailors and machinists as well as compartments for storing tools and accessories. Cabins on the boat and bridge deck are provided for the passengers and officers, these teak structures being reinforced by substantial iron frames and fitted up most comfortably in the interior.

The service of the whole engine plant is quite uniform, crude oil being used for the operation not only of the main engines but of the auxiliary machinery, while even the donkey boiler, built into the deck, is heated with oil. The main engine plant comprises two directly reversible marine Diesel motors, on the Hesselman system, working on the two-stroke cycle. Each engine comprises four working and two air pump cylinders, and yields an output of 260 effective and 345 indicated horsepower at 280 revolutions per minute. Suitable reservoirs are provided for storing the compressed air required for starting and reversing, thus enabling the engine to be started and reversed ten to 15 times in succession without replenishing its store of air. On account of the tropical climate of the country, special arrangements had to be made for a rapid circulation of the cooling water, so that the water temperature might not exceed 30 degrees C. The fuel, after being purified and pre-heated, is pressed onto the nozzle by adjustable fuel pumps.

The piping for the main engine could be readily installed in the engine room in conjunction with the auxiliary machinery and water filters for the cooling water. The following auxiliary machinery has been provided: An auxiliary compressor to be used as stand-by for supplying the steering apparatus and replenishing in cases of emergency the starting air reservoirs. This set comprises a 5.5-horsepower kerosene (paraffin) motor working at 420 revolutions per minute, and a compound compressor and intermediary cooler which supplies air at 10-12 atmospheres pressure. This motor is at the same time coupled on a common base to a donkey pump. A motor dynamo, operated by a two-cylinder, 10-horsepower, 420 revolutions per minute kerosene (paraffin) motor, has been installed for generating electric current. The steering apparatus comprises a steam and hand steering gear designed for compressed air operation, which is controlled from a hand-wheel column on the upper deck.

The engine plant provided ensures a speed of 10 miles with full load, the fuel consumption being 243 pounds, so that about 600 sailing hours without replenishing are possible with a single store of 65 tons, which corresponds to an up and down trip on the La Plata.

On her passage from Hamburg to Montevideo, the *Hermann Krabb* amply demonstrated her seaworthiness, as the heavy seas in the channel and the Bay of Biscay, as well as alongside the coast, were an ample test of the maneuvering capacities of the vessel.

LAKE STEAMSHIP MERGER.—The Interlake Steamship Company, formerly the Lackawanna Steamship Company, has effected the merger of a large number of Lake ore boat interests, purchasing thirty-two vessels, giving the company a fleet of thirty-nine ships, the second largest fleet on the Great Lakes.

Filtering Feed Water

BY CHARLES S. LINCH

While in years past little or no attention was paid to boiler cleanliness, to-day it is becoming more generally appreciated that cleanliness in a boiler means absence of dirt—and dirt, as Lord Palmerston has defined it, is matter out of place. A boiler was designed not to be a receptacle of foreign matter but to contain water and steam. The doctors of the present day are trying to prevent disease by stamping out dirt, rather than using correctives. There is nothing which is more amazing than to see some owners permitting their engineers to use correctives in the form of boiler compound of which little is known, pouring it in without any knowledge to regulate the conduct of the "dirt."

Exercising the utmost care it is absolutely impossible to prevent some oil getting into the steam. Piston rods must be swabbed, and a greater quantity of oil is taken into the low-pressure cylinder by the vacuum which causes the greater quantity to find its way into the steam. Auxiliary engines are the cause of the greatest trouble with oil passing over with the steam, because the oilers as a rule see that these are given a more than ample dose of oil, the temptation to do so being irresistible.

The function of the feed filter is to extract the oil, grease and other dirt from the feed water. The work done by a grease extractor or filter can be judged from the following analysis, made by Mr. A. Norman Tate, of the deposit from an Edmiston filter: Fatty and oily matter consisting of

Fatty matter.....	29.96	
Mineral oil	19.42	
Water	29.6	
		78.98
Mineral matter consisting of		
Silica	1.49	
Oxide of iron.....	16.46	
Lime	0.75	
Copper	2.32	
		21.02
		100.00

The copper appearing largely in solution with fatty acids. The following analysis by Messrs. Pattison & Stead, of Newcastle, is very interesting, as it is of the sludge removed from the Harris filters in the Atlantic mail steamer *Campania*:

Heavy oil dissolved out with ether.....	55.34
Organic matter insoluble in ether.....	4.69

Mineral matter left on calcining the residue, comprising iron oxides in greatest proportion, copper, zinc, oxides, salt and a

Little sand	20.9	
Moisture	19.76	
		100.00

Feed water from the condenser (in engines where oil is used in the cylinders of main or auxiliary engines) when put in a glass bottle or sample tube, has a milky or opalescent appearance and soapy feeling. After passing the filter it should be quite clean. The deposit on filter cloths and grids is, as a rule, a dark, heavy and sticky conglomerate, resembling mud. The requirements of a grease extractor or filter should then be as follows:

It will consist simply of a mass of finely divided material not easily decomposed by the feed water.

All feed water must be made to pass through it, and in

passing is cleared of matter held in suspension, this being due to the straining and partly due to exposure to contact with numerous surfaces on which all matter which is of greater consistency than pure water adheres. The filtering material becoming laden with this deposit must be frequently cleaned, and when necessary renewed. The effective duration of a filter depends upon the area of filtering material at right angles to the direction of flow. It will also depend upon the thickness of the filtering material, or, what will be the same thing, the number of strata of a given thickness.

The restrictions of space in the engine room of the average ship render it necessary that the filters be made of small dimensions, and hence they require frequent cleaning. The proper location of the filter is most important. If the filter is situated between the feed heater and boiler the water may be 220 degrees F. or more. At these temperatures some of the oily matter in the feed water is near its vaporizing point, while the remainder is liquified to such a degree that a quantity passes easily through the filter and as readily as pure water would.

Under such conditions as above, filtration is conducted under boiler pressure, and hence the shell, bonnets, joints, etc., of the filter must be heavy. The work of filtration should be at the lowest possible temperature, for the following reasons:

Oil, grease and other matters are in their most glutinous, viscous state, or, in other words, their least fluid conditions. Some impurities which are in suspension at 100 degrees F. are in solution at 250 degrees F.

The filter will therefore be more efficient at lower than at higher temperatures, and it is very desirable to keep the feed water heater, the cold and hot pumps, valves and pipes to and from them clean, and this can only be accomplished by passing the filtered water through them, and this means that the suction side of the hot well or feed-tank pumps is the most desirable location. This location presents difficulties, however. The hot well works as a rule under very little "head," and the resistance of the filter has to be overcome by the negative pressure in the suction pumps, and this resistance must not exceed 5 pounds per square inch, and less than this is desirable. Hence we either have to adopt larger filters or more frequent cleaning will be demanded.

We may ask the question, "Why not place the filter on the exhaust steam entrance to the condenser and eradicate the grease trouble entirely from all interiors beyond the cylinders?" The auxiliary engines are by far the heaviest consumers of oil, and all auxiliary piping and condensers are therefore more especially guarded by these exhaust steam filters. The objections to the use of exhaust steam filters are, however, the very high temperatures, inefficient filtration, and great area of filtering medium necessary to prevent injurious back pressure.

Summing up, we can see that the most desirable, practical and convenient location for the filter is the discharge of the hot well pumps, or between the hot well pump and feed water heater, for a low temperature is then secured, and the pumps give head enough to permit the filter being placed at a level to suit engine room arrangements, permitting the accessibility it demands.

A feed water filter should be so designed that renewals can be made simply and quickly. It should also have a device for applying a reverse current of steam to enable temporary cleaning being made. It should be light, strong and durable, cheap to maintain, economical of space, simple in design and moderate in cost. The filtering surface should be at least 250 to 300 times the area of the feed water pipes. It should be strictly borne in mind that no filtering area is efficient after the clogging point has been reached. Many statements are made that certain materials are used and that the efficiency never becomes impaired. This is not true. It makes no difference what material is used for filtering the feed water if the area is insufficient to take care of the demands of the boilers. Fil-

tering cannot therefore be efficient beyond this clogging point.

Repeated experiments and tests have proved that the first layer through which feed water passes should in no cases be less than 100 times the area of the feed water pipe with a normal flow of water through it.

The requirements which should be met in a feed water filter are as follows:

First. It must not have single filtration, but as a matter of fact double filtration and over should be obtained. The filter would thus present a total surface area not less than 320 times the area of the feed water pipe.

Second. The facilities with which renewals or change can be made must receive particular attention. The attachments should be reduced to a minimum, at the same time assuring absolute safety. The simpler and more rapid method of dismantling is a very important feature, and is on shipboard an absolute necessity.

Third. A most important feature is the special attachments for applying a reverse current of steam, enabling a large proportion of the collected oil to be blown out and drained off through the drain cock. The filter medium should be Turkish toweling ("Linen Terry Cloth").

In a filter, the radial plan of filtering cages admits extreme surface area within any given cylinder. The over-heating of crown sheets, due to dirty feed water or so-called grease damage, as a rule, occurs after fires are banked, for then, the formation of steam being checked, the circulation of water is reduced, and hence grease will settle and become partially baked to the surface or tubes on which the deposit is in contact, with the result that it prevents contact of water with the crowns, resulting in the overheating of the plates to such an extent that bulging is very likely to and frequently does occur, even though the temperature at this time is very low. Grease does not dissolve or decompose, nor will it remain on top of the water in a boiler. It assumes the form of a sluggish conglomerate held in suspension for a short time. After boiling, this conglomerate mass becomes sticky and adheres to the shell, tubes and crown. It is becoming more fully realized by the average ship owner that all methods of preventing impurities from getting into the boiler which would in any way jeopardize not only the life of the boiler but the safety of same is a matter that cannot be ignored. Not only with the use of impure feed water is the life of the boiler reduced, but admitting that there would be no danger of bulging crowns, or other injurious effect to the generator, the consumption of fuel is enormously increased by deposits on the heating surface. Therefore, in a feed water filter the feed water, after passing through it, must not contain the least degree of insoluble matter.

Clean tubes and surfaces mean efficient heat transmission, therefore by keeping the impurities from the boiler there is a dividend returned in a high percentage of fuel saving.

LAUNCH OF THE STEAMSHIP CONGRESS.—The twin-screw coastwise steamship *Congress*, designed by George W. Dickie, and under construction by the New York Shipbuilding Company for the Pacific Coast Company, was launched May 17. The ship is 442 feet 6 inches long over all, 55 feet beam, 38 feet 5 inches depth to shelter deck, 54 feet 10 inches depth to boat deck, with a gross tonnage of about 8,000. Propulsion is by two triple-expansion reciprocating engines of 3,000 indicated horsepower each, designed to give the vessel a speed of 16½ knots. Steam is supplied by ten boilers, arranged in two fire-rooms and fitted for burning oil fuel. The hull is subdivided by a double bottom, ten watertight transverse bulkheads and a longitudinal bulkhead on each side of the ship in way of the boiler spaces forming an inner skin. The cargo holds have a capacity of 200,000 cubic feet, and accommodations are provided for 410 first class, 106 second class and 108 third class passengers in addition to a crew of 175.

Empirical Method of Screw Propeller Design

BY PETER DOIG

At the present time there are several well-known first principle theories of propeller action, all of which seem to be practically inapplicable to the problems confronting the naval architect and marine engineer. This unsuitability results from various premises known to be incorrect, *e. g.*, that the blade has no thickness, and that area of blade has no effect. Furthermore, as casual inspection of these theories shows, their basic assumptions are entirely different, the action in the region of the screw being so little known that considerable divergence exists in the opinions of the authorities from whom the theoretical formulæ emanate.

It thus results that the methods of propeller design in vogue are almost purely empirical in their nature. They are of two kinds, which may be described as follows:

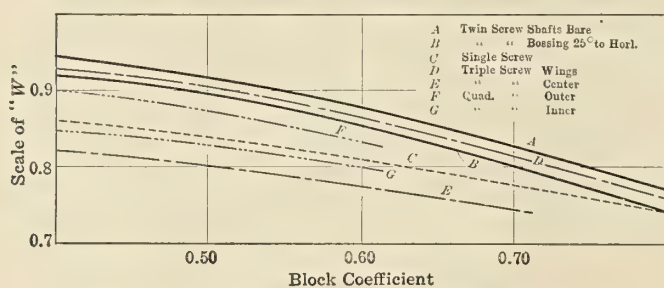


FIG. 1.—WAKE FACTOR (LARGE SHIPS)

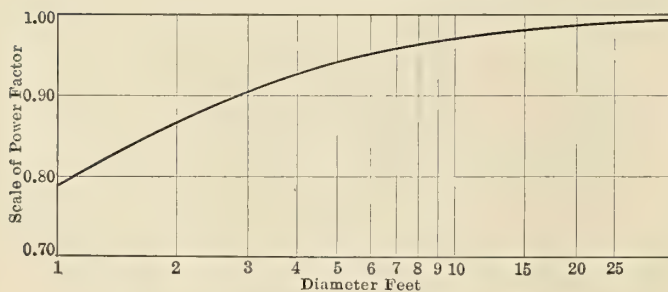


FIG. 2.—POWER FACTOR

(a) By comparison with similar ships or—an extension of this method—by generalizations based on the results of full-size practice.

(b) By deduction from experiment on models of screws and hulls, relating these miniature results to experience with the full-size ship.

From the first of these it is possible to ensure a fairly good result in most cases, but only when the experience at command is sufficiently comprehensive. And betterment of, or even equality to, past performance must remain somewhat uncertain, an average merit of design being the utmost claimable with skillful and cautious treatment.

The applicability of model experiment rests upon the so-called "Law of Comparison" between the model and the large propeller. From all theoretical considerations of screw action it follows that for a screw advancing with a certain slip, the thrust and torque on the shaft vary as the square of the speed of advance and as the square of the linear dimensions of the wheel. This relation would hold absolutely provided the motions produced in the water around the model and full-size propeller were similar in every respect. Perfect continuity of motion would also be necessary for complete fulfilment, and as this is only possible in a perfect fluid there are resulting dissimilar eddying motions with some departure from the so-called "Law."

For purposes of design, this relation is best formulated that power absorbed varies as the square of dimensions and the cube of the speed of advance. Experiments with model screws at various speeds show that the power absorbed (at a given slip) does vary very closely with the cube of the speed. Moreover, there is practical support of similar trend; for when the results of carefully taken measured mile trials are analyzed, and the slip of the wheel plotted on a base of speed, it will be found that the power driving the ship is varying very nearly as the third power of the speed over any range where the slip has an approximately constant value.

That the power absorbed is nearly proportional to the square of linear dimensions, provided slip and speed are the same, has been shown in the Washington Experimental Basin by a

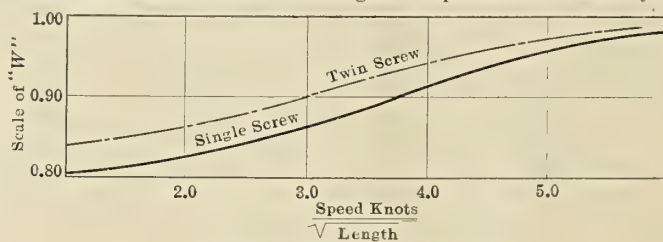


FIG. 3.—MOTOR BOAT WAKE FACTOR

series of experiments on wheels varying only in scale, the diameters being from 8 inches to 24 inches. Some divergence from the law was observed, the larger screws absorbing less power than they should if it were strictly true. Nevertheless, many practical rules have long been in use based on power being absorbed proportionate to the square of the diameter.

TRUE SPEED OF PROPELLER THROUGH WATER

To test by means of trial data the degree of accuracy of this extension, the real speed of advance of the propeller through the water must be known. In other words, we must be able to connect in some consistent way the speed of the water in the vessel's wake in which the screw works with the speed of the ship. When this can be done the real slip of the screw is computable; and the net power applied to the wheel being known after proper allowance has been made for mechanical losses between the engine and screw, the trustworthiness of the "Law" in question can be gaged and proper power factors found correcting for its divergences from literal truth in extending model experiments to large wheels.

At present the only manner in which the ratio of effective speed of propeller through the wake water to speed of ship can be found is by experiment on models of hull and propellers, as conducted originally by R. E. Froude, and followed up by Pecararo, Luke and others. These investigators have shown that the most important factor influencing the relative speed of the following wake is fullness of ship's form, speed of ship and dimensions and position of screws being, within limits, secondary in importance. Mr. W. J. Luke, of Clydebank, has further shown that when bossed framing and plating are fitted over the outboard part of the shaft the angle of inclination of the webs and the direction of turning of the screws have great influence on the effective speed of the water in the region of the propeller; while with no bossing the direction of turning seems to make little difference on the wake. It appears also from this authority's experiments that generally the best angle of bossing with outward turning screws (*i. e.*, starboard, right hand; port, left hand) is between 20 degrees and 30 degrees to the horizontal. The fittings

of bossing cannot be claimed to enhance the efficiency of propulsion to any extent, since the additional resistance due to them seems to wipe out any advantages given to the propeller by their presence.*

Fig. 1 shows the ratios of real speed of screw through water to speed of ship for various arrangements of shaft, all side screws being outward turning. The following notes refer to their derivation and use:

(1) Curves *A*, *B* and *C* have been well determined by numerous model experiments.

(2) Curves *D*, *E*, *F* and *G* apply to all-turbine installations, and were derived by taking into consideration the transverse and fore and aft positions with regard to the hull of the ship and the relatively small diameters of the screws concerned.

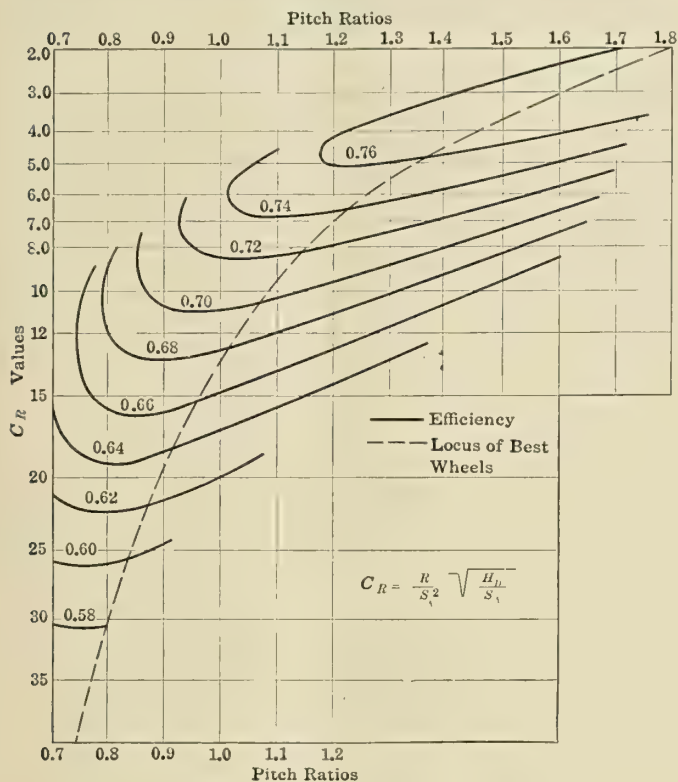


FIG. 4.—CHART FOR PROPELLER DESIGN

(3) It may be noted that a still smaller value of this ratio, "*W*," than that given by *E* should be taken for the center screw on the exhaust turbine of vessels with reciprocating-engined side shafts, since here the diameter is usually relatively very small. (See Mr. Luke's paper referred to.)

(4) With a fine afterbody form, having the "deadwood" of the ship removed, "*W*" should be increased slightly (about .02 to .03) in curves *A*, *B* and *C*, the wheels then being relatively clearer from the hull.

(5) The range of speed over which these curves apply may be taken to be from 0.5 to 1.3 speed-length ratio,

$$\text{or } \left(\frac{\text{speed knots}}{\sqrt{\text{length feet}}} \right)$$

In torpedo craft, where the speed-length ratio may be as high as from 1.6 to 2.0, wave phenomena are so excessive as to cause the wake to be negative in direction, the wheels being situated in a trough in which the motion of the water particles is aft. Hence "*W*" is slightly greater than unity, and may be taken:

In triple screw, wings, 1.02 to 1.06; center, 1.00 to 1.03.

* A full description of the model experiments concerned, with a resumé of all previous investigators' work, will be found in the memoir by W. J. Luke, Trans. I. N. A., 1910.

In twin screw, 1.00 to 1.05, being greatest with high speeds and cutaway sterns.

POWER ABSORPTION

As thickness of blade is a variable which cannot be related to dimensions alone, the writer has used the results of the experiments on very thin three-bladed wheels, made at the Washington Model Basin and published in 1904. These were upon models 16 inches in diameter with a standard root thickness of 9/32 inch, which is much thinner for the diameter than any propeller in practice, being about one-half to one-third of the usual ratio. Adopting the wake factors of Fig. 1, a factor of power absorption of the thin 16-inch screws compared with full-size wheels was obtained from numerous trial analyses. See Fig. 2. This is made up of two components,

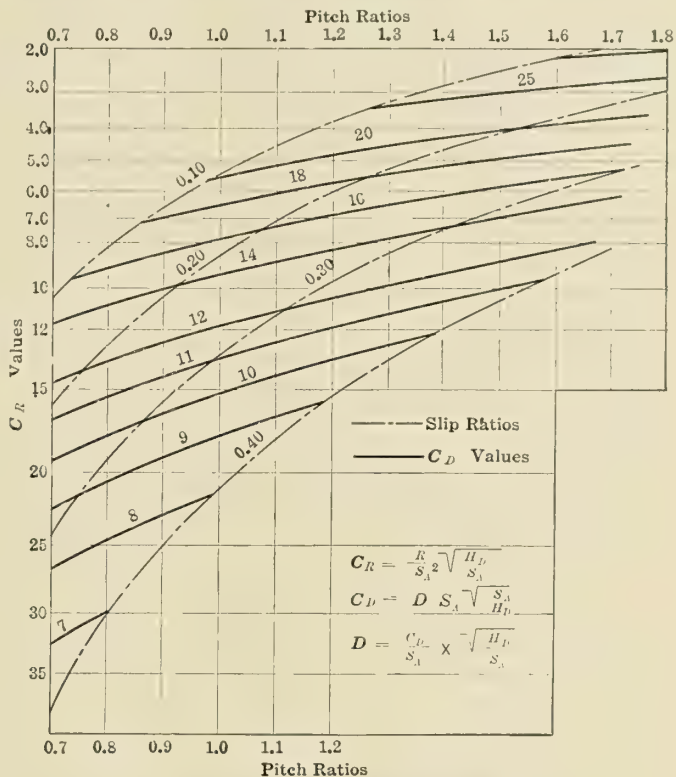


FIG. 5.—CHART FOR PROPELLER DESIGN

representing in terms of power the failure of the "Law of Comparison" and the effect of the greater proportionate root thicknesses of full-size propellers. At the lower end of the curve the former is slight, the effect of blade thickness being predominant. This has been estimated from the Washington experiments on blade thickness, published by Constructor Taylor in his paper "Model Basin Gleanings" (Trans. Soc. Naval Architects and Marine Engineers, 1906).

Fig. 3 gives motor boat and launch wakes as obtained by trial analyses, Fig. 2 being used as the power correction. The base adopted is: speed knots $\div \sqrt{\text{length}}$, which is more readily computed than the coefficients of fineness of these craft; indeed fineness ceases to have any meaning with the hydroplane type, in which the relative speeds on this basis are very high, wake factor being practically unity.

DESIGN OF WHEELS

The variables to be estimated in obtaining the best propeller for a given set of conditions are, in the order of importance:

- (1) Diameter.
- (2) Pitch.
- (3) Surface of blades.
- (4) Thickness of blade.
- (5) Number of blades.

(6) Shape of section across blade.
(7) Outline shape of blades.
The present paper proposes to treat only on the determination of the first three of these.
Figs. 4 and 5 are design charts made from the Washington model results referred to above. They are for a standard blade thickness as stated, and also for a ratio of helicoidal

standard blade area ratio are obtained. The change in pitch and efficiency for other disk area ratios will be found on Figs. 8 and 9.
In practice with ordinary low or moderate revolutions and power, the best area to use is conditioned by the following considerations. Inspection of Fig. 9 will show that the smallest disk area ratio has the highest efficiency. Hence it

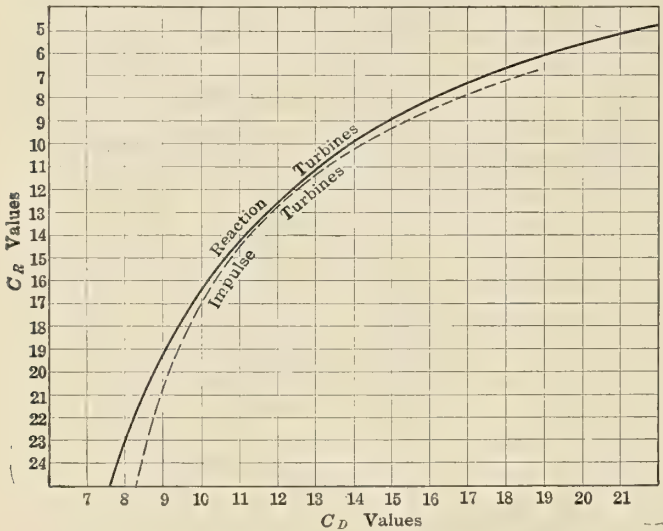


FIG. 6.—CHART FOR DESIGN OF TURBINE PROPELLERS

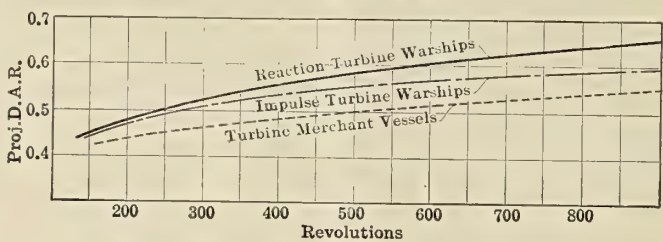


FIG. 7.—GUIDE CHART FOR PROJECTED DISK AREA RATIO

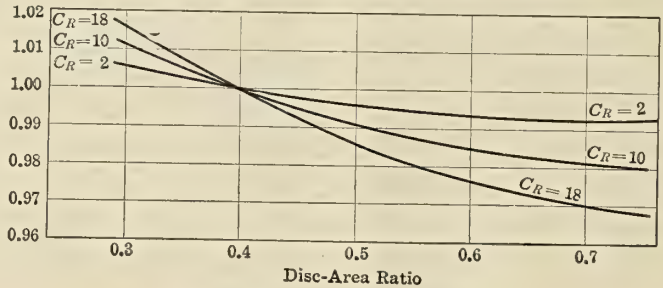


FIG. 8.—PITCH CORRECTION

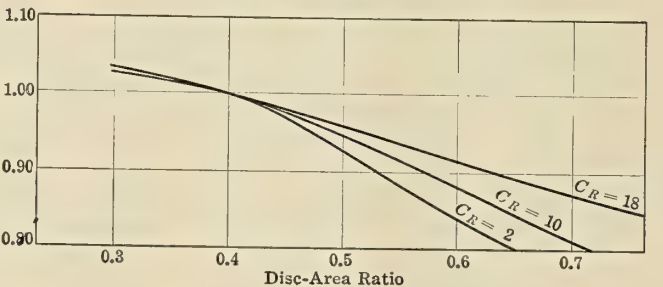


FIG. 9.—APPROXIMATE EFFICIENCY CORRECTION

blade area to area of disk enveloping blade tips of .40. The coefficients used are:

Revolution coefficient $C_r = \frac{R}{S_a^2} \sqrt{\frac{H_d}{S_a}}$
Diameter coefficient $C_d = D S_a \sqrt{\frac{S_a}{H_d}}$

Where R is revolutions per minute.
 H_d , horsepower for design (one propeller).
 S , speed of vessel in knots.
 S_a , speed of propeller through wake = $S \times$ wake factor.
 D , diameter of propeller in feet.

The following table gives the ratio of horsepower absorbed by screw to indicated horsepower or brake-horsepower in various types of propelling machinery:

TABLE I	
Type	Multiplier
<i>Reciprocating Engines—</i>	
Attached air, circulating, feed and bilge pumps	I. H. P. $\times .84$
As above without circulating pump.....	" $\times .86$
All pumps independent.....	" $\times .87$
High-class engines with high pressures and forced lubrication.....	" $\times .88$ to .91
Gasoline engines	B. H. P. $\times .95$
Oil engines (on B. H. P. net, <i>i. e.</i> , on B. H. P. with deductions for power to compressors or scavengers).....	" $\times .94$
Turbines (mechanical loss of 2 percent between point of torque measurement and propeller).....	" $\times .98$

might be inferred that where there is no danger of cavitation through high-thrust pressures or tip velocities, the lowest disk area ratio should be used. On the other hand, this would entail thicker blades for sufficient strength with the relatively narrow root widths, and a loss of efficiency would ensue. This results in the adoption of moderate area ratios in reciprocating-engined ships, and good practice may be tabulated as below:

TABLE 2	
Type of Ships, Etc.	Disk Area Ratio
Single screw full-cargo vessels.....	.32 to .40
Twin screw cargo vessels.....	.35 " .40
Liners—twin screw, moderate speed.....	.35 " .40
Liners—twin screw, high speed.....	.40 " .45
Battleships and cruisers, twin screw.....	.38 " .42
Cruising motor boats and steam launches.....	.35 " .45
Racing motor boats.....	.50 " .60
Towboats	.50

It should also be noted that Fig. 9 somewhat exaggerates the drop in efficiency with increase in blade area, since the model propellers on which it is based were of uniform thickness for all areas. In other words, other factors being the same, thickness is less the wider the blade, and consequently the decrease in efficiency is probably not so great as shown on the diagram.

Figs. 6 and 7 are based on practice in the design of turbine-

On Fig. 4 will be found the experimental efficiencies and pitch ratios (or pitch $\div$ diameter) for .40 disk area ratio, also the locus of best wheels for all ships except turbine-driven craft. Fig. 5 shows slips and diameter coefficients corresponding. From these two charts the best diameter and pitch for the

driven wheels. Here the proper area or blade width to avoid cavitation is an important consideration, and Fig. 7 shows the average ratios of projected area to disk area, forming a guide chart to the necessary area of blades for varying revolutions. To turn this figure into the developed or helicoidal ratio, the following formula will be found useful for the wide tipped shapes best in wheels liable to cavitation:

Helicoidal area

Projected area = $.80 + .33 P. R.$, where $P. R.$ is pitch ratio.

To show the procedure in designing from these diagrams, and also their reliability, the writer has taken the published trial results of a number of vessels covering the field of marine propulsion, and designed the best propellers for the trial conditions. The actual wheel fitted is tabulated for comparison.

The requisite area to avoid cavitation can be figured on the basis of thrust per unit of projected surface, as suggested by Barnaby; or by taking into consideration tip velocities as favored by D. W. Taylor and others. It should be noted that Fig. 7 is meant merely as a guide in this particular; but practice will be found to be fairly well represented by it. Barnaby's rule is based on the limitation of thrust pressures to $11\frac{1}{4}$ pounds per square inch of projected surface with one foot immersion to tips, an additional $\frac{3}{8}$ pound being allowed for every extra foot of water over the propeller; but higher values seem permissible. These charts are all for three-bladed screws. An equivalent four-bladed propeller may be found by solving for the best three-bladed one and reducing the diameter 6 percent, pitch and area remaining unaltered. A two-bladed wheel to work at the same revolutions and absorb equal power should have 4 percent more diameter, pitch and area being the same as in the best three-bladed screw.

If the diameter found is too large for draft or clearance, the problem becomes to find from Fig. 5 the pitch ratio suitable for the limiting diameter of propeller, C_d being then fixed.

(To be concluded.)

Advantages of Low Ratio of Heating Surface to Grate Area in Boilers

Boiler specifications usually call for a ratio of heating surface to grate area of upwards of 30 to 1, and even as high as 45 or 50 to 1 where forced draft is used. This high ratio of heating surface to grate area naturally means the incorporation into the boiler of a large amount of material, the manufacturing and assembling of which increases the amount of labor involved in building the boiler. It is, therefore, self-evident that the higher the ratio of heating surface to grate area in any given boiler the greater will be the amount of material and labor that goes into the boiler, and as these represent practically all the cost of construction, the first cost or price of the boiler increases almost directly in proportion. In view of the above facts, therefore, it must be accepted as a good policy to keep down the ratio of heating surface to grate area as much as possible consistent with low stack temperatures and the proper absorption of heat by the heating surfaces. This policy has even greater force in the case of marine boilers, as a large amount of heating surface in proportion to the grate area means an increase in the size and weight of the boiler, two factors which it is advantageous to reduce to a minimum in a marine boiler.

The possibility of obtaining better results—that is, the transmission of more heat units from the fuel to the water in the boiler and better evaporation per pound of coal—with a boiler in which the ratio of heating surface to grate area is less than that in the ordinarily accepted type of shell boiler does not seem to be realized by many engineers. By subdividing the heating surface of a boiler into various systems, so that com-

paratively cool water is brought directly over the fire in the primary generating system and by interposing in the path of the gases a secondary section of heating surface containing water at a temperature of the feed water, the gases of combustion as they proceed toward the stack can be brought in contact repeatedly with heating surfaces containing water at nearly the temperature of the feed water, so that when finally delivered to the stack the temperature of the gases can be reduced to a point far below the temperature due to the pressure on the boiler. In other words, more heat will have been transmitted from a given amount of fuel to the water in the boiler than would be possible in the ordinary type of shell boiler where the temperature of the gases cannot be lowered to a point anywhere near the temperature due to the pressure on the boiler, no matter how great the amount of heating surface put into the boiler. All this can be obtained, moreover, as has been proved by tests and practical experience, with boilers which have smaller ratios of heating surface to grate area than 30 to 1. In fact, a boiler with a ratio of 25 to 1 has shown greater economy, besides occupying less space, having less weight and with a lower center of gravity than boilers with a larger ratio of heating surface to grate area. Furthermore, the boiler of small ratio requires less material and labor and, consequently, less first cost for its construction and smaller maintenance costs for its upkeep.

NEW BRITISH INDIA LINER.—Messrs D. & W. Henderson & Company, Partick, launched recently the screw steamer *Chakrata* of about 5,800 tons gross, which is under construction for the British India Steam Navigation Company, London, for their Eastern trade. The vessel is 420 feet long between perpendiculars, 54 feet 6 inches beam and 31 feet 3 inches depth molded. She is classed 100 A 1 in *Lloyd's Register*, and fulfills the requirements of the Board of Trade passenger certificate. The machinery, which has been constructed by the builders, consists of triple-expansion engines having cylinders 28, 46 and 77 inches diameter and a stroke of 48 inches, supplied with steam at 180 pounds pressure by four single-ended boilers.

STANDARD OIL TANK STEAMER RICHMOND.—The tank steamer *Richmond*, launched recently by the Fore River Shipbuilding Company, Quincy, Mass., for the Standard Oil Company, is 435 feet long overall, 54 feet beam, 31 feet 6 inches depth, with the hull subdivided into sixteen tanks for carrying 2,250,000 gallons of oil in bulk. The pump room is located forward and the propelling machinery aft. The main engine is a surface-condensing, quadruple-expansion reciprocating engine, with cylinders 23, $32\frac{3}{4}$, 49 and $71\frac{1}{2}$ inches diameter, with a stroke of 51 inches, turning up to eighty-five revolutions per minute. Steam is supplied at a pressure of 220 pounds per square inch by three cylindrical boilers 14 feet 2 inches diameter arranged to burn fuel oil. On a 25-foot draft the vessel will develop 3,000 indicated horsepower, steaming at $11\frac{1}{2}$ knots.

DETERMINATION OF STRESSES IN A VESSEL'S HULL AT SEA.—During a recent voyage of the steamship *Ancon*, from New York to Panama and return, an interesting series of tests was made by Mr. James E. Howard, of the Bureau of Standards, Washington, D. C., to determine the magnitude of the stresses set up in the various members of the ship's hull by the pitching and rolling of the vessel, as well as by the vibration of the propelling machinery. This work was accomplished by means of a special strain gage designed to measure elongations down to $1/100,000$ of an inch. An outline of the results of this investigation will be published in an early issue of this journal.

The Quadruple Screw French Liner *Lutetia*

The steamship *Lutetia* is the first mail boat built to the order of the Compagnie de Navigation Sud-Americaine in fulfillment of their contract with the French Government. The keel of the vessel was laid June 18, 1912, and she was launched on March 23, 1913, at the Atlantic yard of the La Société Anonyme des Chantiers et Ateliers de St. Nazaire (Penhouet). The *Lutetia* will be the largest liner running between Continental ports and South America. Her main particulars are: Length over all, 599 feet 5 inches; breadth, 64 feet 3 inches;

as there was ample room for the vessel to come to rest before anchoring.

The hull is built of Siemens-Martins steel throughout. A double bottom has been worked from end to end of the ship, and is divided into ten water ballast compartments having a total capacity of 1,750 tons. The hull is divided into twelve watertight compartments by athwartship bulkheads, three additional compartments being located in way of the boiler and engine rooms. In all twenty-three watertight doors are

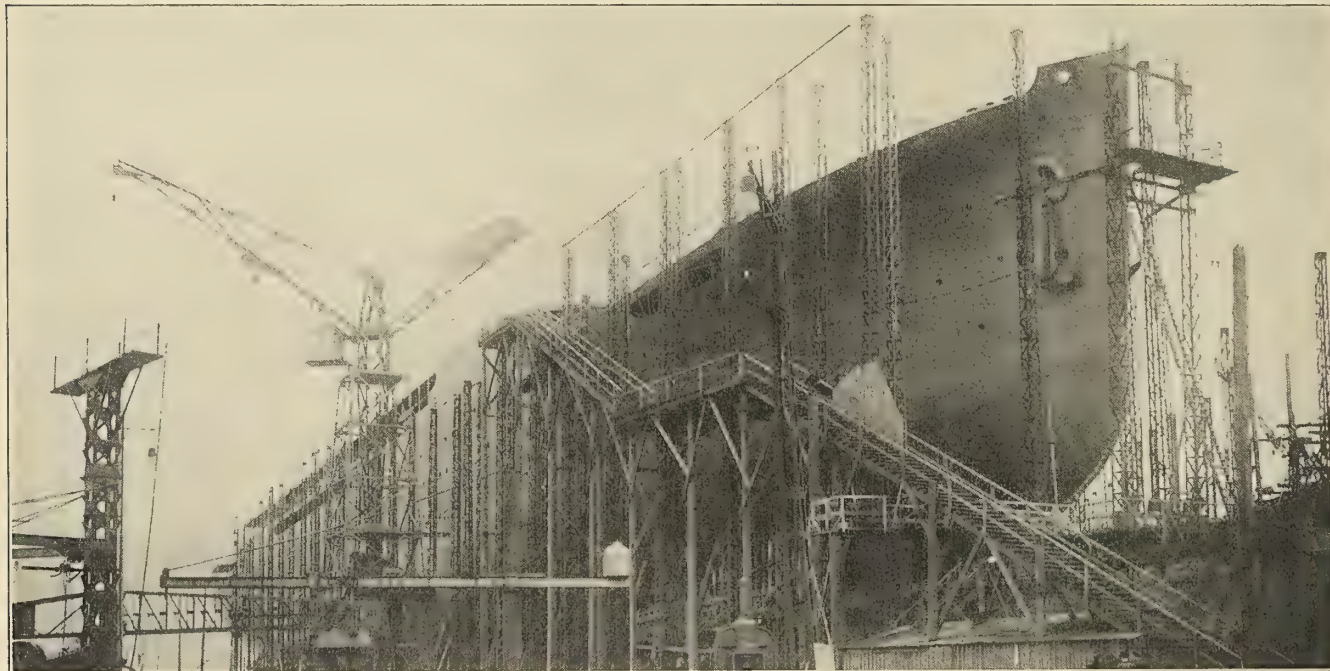


FIG. 1.—FRENCH LINER LUTETIA JUST BEFORE LAUNCHING

depth from main deck, 40 feet 8 inches; draft, astern, full load, 23 feet; displacement, 15,600 tons; gross tonnage, 14,400; indicated horsepower, 19,000; speed, 20½ knots. The vessel was launched according to the usual practice at the Atlantic yards; that is, with a double cradle. The ways in this case were 470 feet long and 4 feet wide with a declivity of 6 percent. No drags or chains were used to check the vessel,

provided through the bulkheads in order to facilitate the crew's work. These doors are hydraulically operated, and may be closed simultaneously from the navigating bridge. Ballast and special pumps are provided capable of discharging 400 tons of water per hour in case of emergency.

From top to bottom the ship is divided by seven decks, designated, respectively, A, B, C, D, E, F and G, D being the main deck.

Provision has been made for 300 first class passengers, 106 second class, 80 third class and 600 steerage passengers. The vessel's crew includes 23 officers, 40 deck hands, 133 men for the engine department and 123 pursers, stewards and stewardesses.

All accommodations throughout the ship are heated and ventilated with the latest devices especially designed for use on board ship in hot climates. Three electrically-operated elevators furnish connections to three decks.

Steam at 200 pounds pressure is supplied by eighteen three-furnace cylindrical boilers operated under Howden's system of forced draft. The boilers have a grate surface of 1,210 square feet and a heating surface of 47,000 square feet. The products of combustion are taken care of by three funnels, each 10 feet in diameter and extending to a height of 115 feet above the grate bars.

The propelling machinery consists of a combination of triple-expansion and turbine engines operating four shafts.



FIG. 2.—STERN VIEW

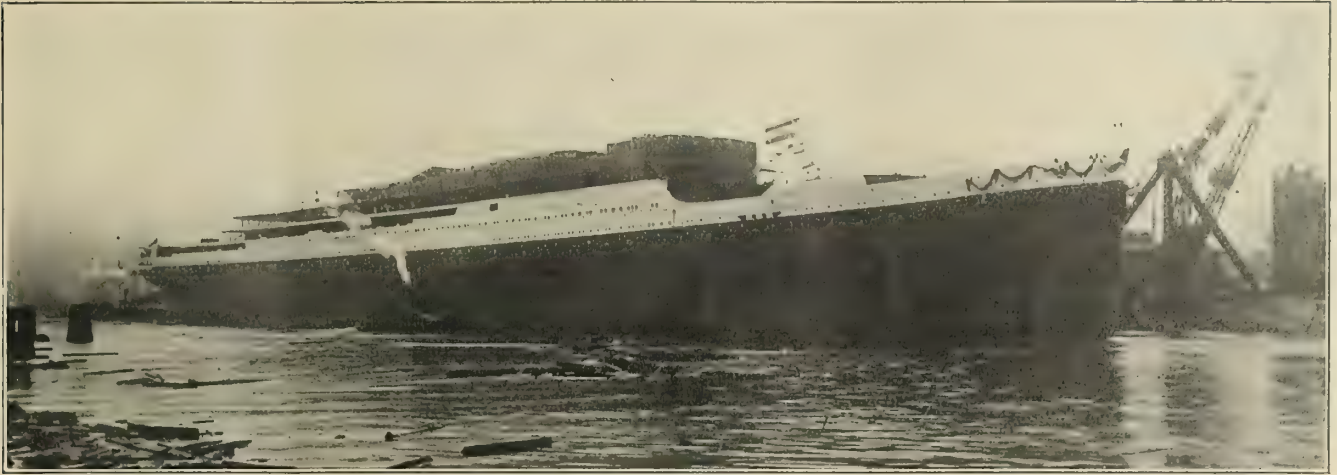


FIG. 1.—HAMBURG-AMERICAN LINER VATERLAND, THE LARGEST VESSEL IN THE WORLD

The reciprocating engines are designed to operate at 105 revolutions per minute, and each engine has four cylinders, 41, 57, 65 and 65 inches diameter, respectively, with a common stroke of 47 inches. When running ahead the main engines exhaust into two independent Parsons low-pressure turbines, working under the reaction principle, the steam being finally delivered into two independent "Contraflo" condensers of 11,000 square feet cooling surface. The practice of installing two reciprocating engines, delivering the steam into two independent low-pressure turbines, was used for the first time in the world by the same builders on the French transatlantic liner *Rochambeau*, and the same type of machinery will be used in the French navy on board the powerful battleships of the *Normandie* class to be laid down during the present year.

The propellers, operated by the reciprocating engines, are 16 feet 5 inches diameter and 23 feet pitch, while the turbine screws are 6 feet 7 inches diameter with a similar pitch. All of the propellers are made of bronze.

The electric plant consists of three dynamos, operated by reciprocating engines, their power aggregating 300 kilowatts at 110 volts. One thousand seven hundred and fifty lamps will be used throughout the vessel.

Launch of the Hamburg-American Liner Vaterland

The steamship *Vaterland*, which is the second of three sister ships of the *Imperator* class now building for the transatlantic passenger service of the Hamburg-American Line, was launched April 3 from the yards of Messrs. Blohm & Voss, Hamburg, the christening ceremony being performed by Prince Rupprecht of Bavaria. While the exact dimensions of the *Vaterland* have not as yet been disclosed, she is reported to be about 4,000 tons larger than the *Imperator*. The propelling machinery, as in the *Imperator*, is a turbine installation aggregating 61,000 shaft-horsepower at 180 revolutions per minute, driving four shafts and designed to give the vessel an average speed of 22½ knots. Accommodations are provided for 4,050 passengers, consisting of 700 first, 600 second, 1,050 third and 1,700 fourth class passengers, which, with a crew of 1,200, will bring the total number of persons on board up to 5,250. The life-saving equipment will consist of eighty-three lifeboats, two of them being motor boats, making provision for more persons than will be carried on board the ship.

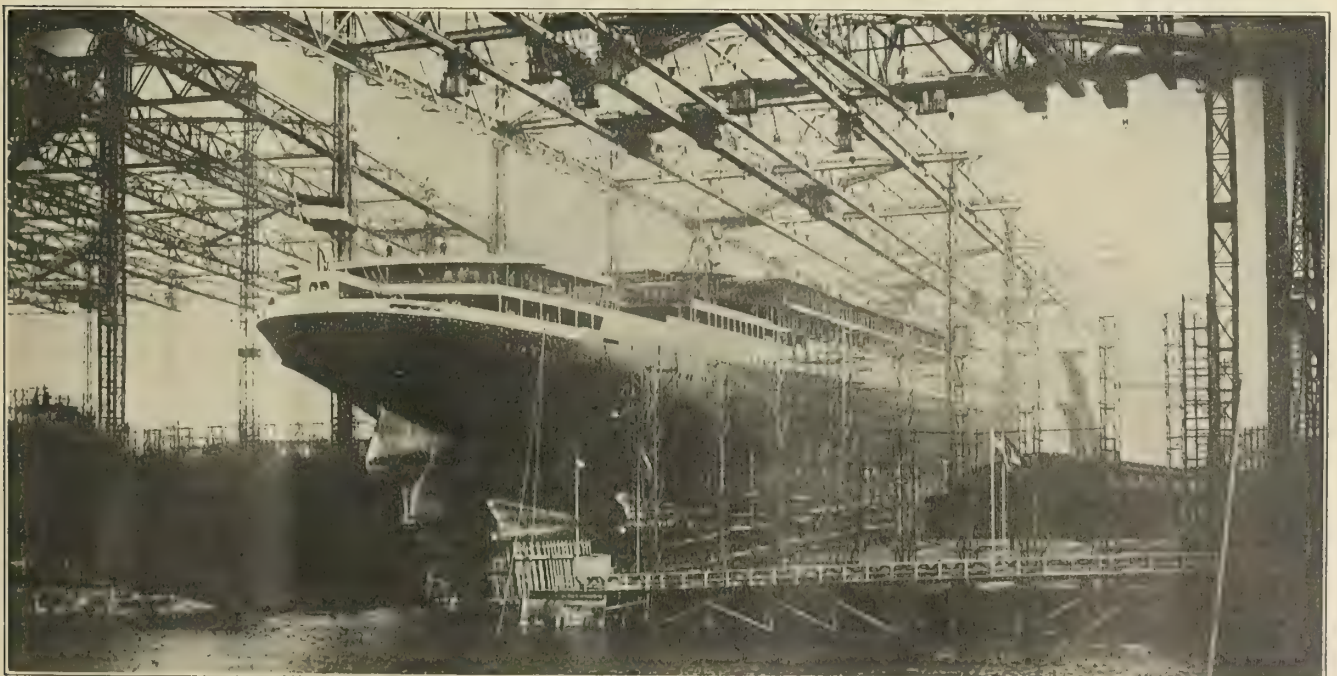


FIG. 2.—THE VATERLAND ON THE BUILDING SLIP

Power Lifeboats—The Lundin Decked Type

Along with the general revival that has taken place during the last few months in the construction and building of lifeboats, a new departure has been entered upon which is of special importance, and that is the adoption of power lifeboats as a part of the life-saving equipment on board passenger ships. Only recently the United States Board of Supervising Inspectors made a new ruling providing that passenger ships hereafter will be permitted to carry a certain number of power lifeboats in addition to the regular lifeboat equipment, and similar rules have been made by the British Board of Trade and foreign governments. The great utility of such equipment in the event of disaster in mid-ocean is now realized as never

equipment has been developed in accordance with natural conditions and from long experience. The length of the average sea-going lifeboat for this service is from 28 to 36 feet, as a boat whose length is within these limits has been found best adapted for handling through surf and in heavy seas. This should be borne in mind when considering the construction of power lifeboats for sea-going vessels, as it is a conclusion reached by experienced seamen after years spent in facing the dangers of rescue work at sea with the sea in its angriest moods.

On the other hand, according to recent proposals made here and abroad, there seems to be a tendency by the authorities

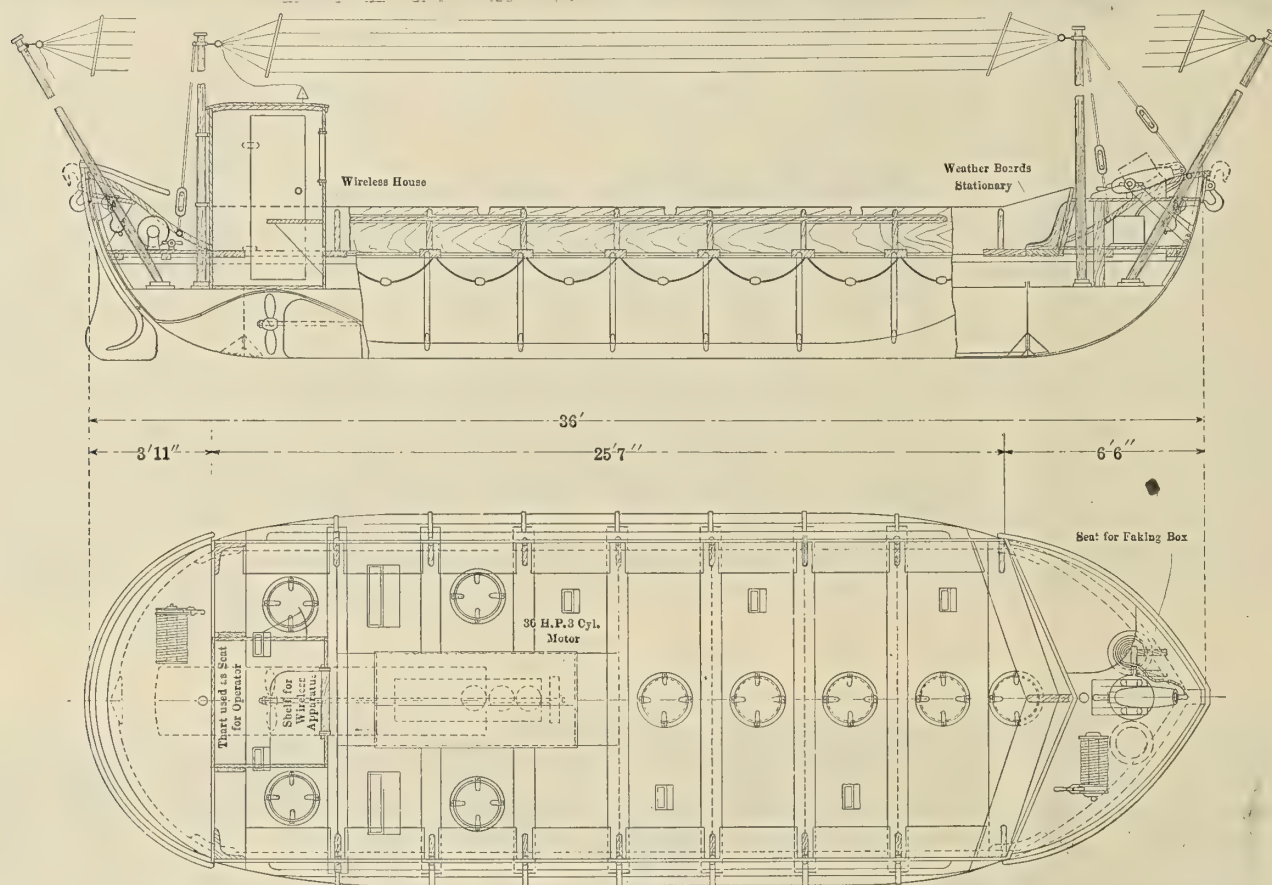


FIG. 1.—LUNDIN POWER LIFEBOAT WITH STATIONARY WEATHER BOARDS, REELS, WIRELESS HOUSE AND EITHER VERTICAL OR SLANTING MASTS

before from the experience gained in the *Titanic* disaster, and every possible effort should be made by shipbuilders, shipowners and shipping authorities to establish, through the forthcoming International Conference on Safety at Sea, suitable recommendations for adequate equipment of this type.

In considering the installation of power lifeboats, however, there are important questions to be decided; for, although power boats in themselves have been developed to a very high standard as pleasure and commercial boats, yet the problem of providing a power lifeboat brings in new features which have not been of great importance in the ordinary power boat. It is, of course, perfectly feasible to build power boats of any desired size, but when it comes to the handling of such boats on board ship in the event of disaster, and afterwards in a rough sea, there are several reasons why the size of the power boat should be limited.

For guidance in this direction, a valuable lesson can be learned from the life-saving departments on shore, where the

and shipowners toward the adoption of comparatively large power lifeboats capable of accommodating from 200 to 300 persons each. The idea apparently is to provide a decked type of boat with accommodations for the passengers below the deck. This would mean, in the case of, say, a 50-foot boat, which could not, without dangerous overcrowding, accommodate more than 200 persons, that the passengers would be packed very closely into a very small space. In fact, in such a boat, allowing for the necessary room forward and aft for lines, releasing gear, engine and wireless equipment, there would be an area in the boat of not more than $2\frac{1}{2}$ square feet per person. By way of comparison, it should be remembered that in an open-decked boat, such as the Lundin decked lifeboat, the passengers, while not sheltered, each have an area of $3\frac{1}{4}$ square feet when the boat is loaded to its rated capacity.

Moreover, a power lifeboat with two hundred or more frenzied passengers packed into a small space below decks,

would become practically uninhabitable in a very short time, especially in bad weather. The passengers would instinctively seek the freedom and fresh air on deck even at the risk of exposure to the weather and water, since when on deck they could see what is happening, and would have a better chance to shift for themselves in case of disaster to the lifeboat. A rush to the deck in such a boat, however, would mean one of two things: Either the stability of the boat would be seriously impaired, or, if a few were allowed the freedom of the deck and the rest were compelled to remain below, the passengers would be divided into two classes, with unequal chances of self-preservation, a condition that should not exist in a case

heavier weight, strike the hull with a far greater and more destructive blow than would a smaller boat. Should an accident occur while launching the boat, the disablement of such a large unit would leave a great number of people wholly unprovided for, even if they were not killed by the accident. On the other hand, with smaller units, such accidents would probably be less likely to happen, and, furthermore, if an accident should occur fewer lives would be imperilled, and there would be a better chance of picking up those who were thrown into the water without seriously overcrowding the other boats.

The use of a large power boat, as we have already re-

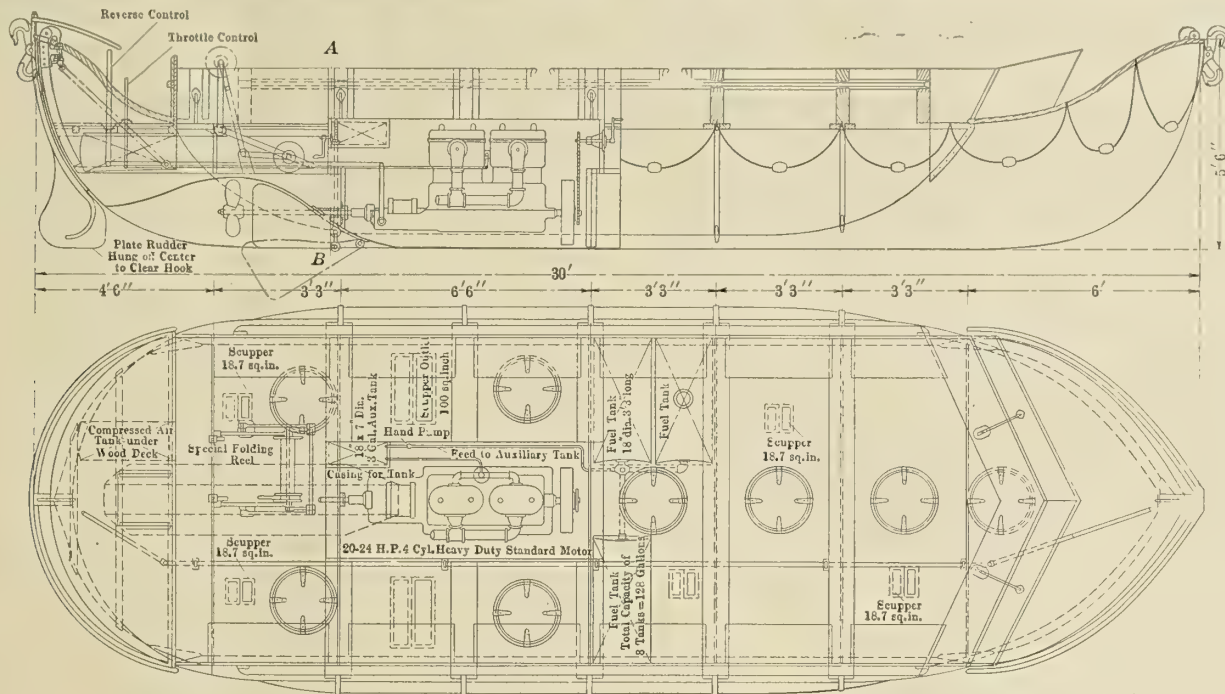


FIG. 2.—LUNDIN POWER LIFEBOAT WITH FOLDING SIDES AND FOLDING REELS

of life and death. The possibility of keeping up any kind of order with such a big, and perhaps frenzied, crowd of people, especially if the weather is rough, would be very small. Housed-in power lifeboats should be limited in their capacity to the number of persons that can be carried safely on the deck of the boat.

Another most important thing to be considered is that when a power lifeboat is launched over side from a vessel, it is quite unlikely that the engine can be started just as soon as the lifeboat is water-borne. The possibilities and the danger of a delay in starting the motive power of a lifeboat are too great to be ignored; the boat should, for this reason, be small enough and of such a design that it can be handled easily by hand, thus enabling the crew to push away from the vessel and maneuver until the engine is started. A large boat, heavily loaded, would have to depend entirely upon the prompt starting of the engine in order to get away immediately from the side of the ship, otherwise the danger of a collision between the lifeboat and the side of the ship might not be averted, especially on the weather side of the ship.

A large lifeboat, of course, must be very substantially built; including the superstructure or deck portion, which must be sufficiently strong to prevent the sea from smashing it in and washing into the boat; for in that case the danger to the passengers would be enhanced. One has also to remember that the lifeboat, fully loaded, is hanging suspended from only two points when it is handled under davits. A large boat of sufficient strength, however, means an extremely heavy weight to be handled. Such a heavy craft in launching would be exposed to serious damage, for a heavy boat, although built of stronger material than a smaller boat, would, on account of its

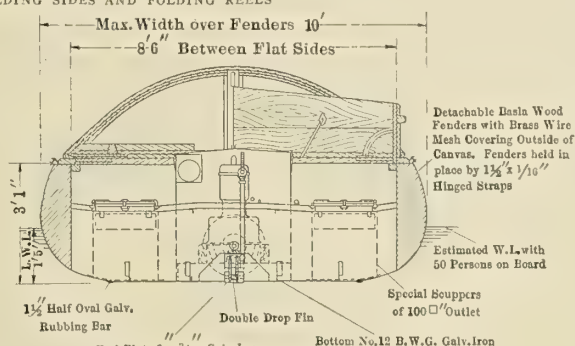


FIG. 3.—SECTION OF LUNDIN POWER LIFEBOAT

marked, involves the handling of extreme weights by the lifeboat launching equipment; for in a strongly-built 50-foot boat, the weight of the boat and the necessary launching equipment would probably average something like 270 pounds per person carried, and this, as compared with only 142 pounds per person for a standard 30-foot lifeboat, or an average of only 110 pounds per person, as is the case with the nested 30-foot Lundin decked lifeboat, under Welin davits, makes it evident that the question of weight of the life-saving equipment per person increases much more rapidly than the capacity of the boat. The weight of the launching equipment which would be necessary to handle the heavy boats is, of course, increased in the same proportion as the whole arrangement, which in turn would mean a substantial reinforcement of the hull and a corresponding addition of weight to the ship.

Judging from the difficulties and dangers which would probably be encountered by using large power boats of the enclosed cabin type as a part of the life-saving equipment on

board passenger ships, it would seem to be a much wiser course to use smaller boats of the open-decked type and a greater number of units. If the length of the power lifeboats were limited to a maximum of, say, 36 feet, the obvious advantages of greater safety to the occupants of the boats, together with safer and more rapid handling of the boats, would undoubtedly be secured.

In general there are seven most important and essential features which should be incorporated in a successful power lifeboat, as follows:

1. It should be as nearly uncapsizable as possible rather than a self-righting boat.
2. It should be thoroughly seaworthy, with positive and sufficient self-bailing qualities to quickly relieve itself of any water that might be shipped.
3. It should occupy a minimum height on the deck of the steamship with as great carrying capacity as possible.
4. It should be of such size and form as to be maneuvered by hand when first launched.
5. Means should be readily available for connecting the power boat to the regular lifeboats for towing and for connecting with a rescue ship.
6. It should carry a line-throwing gun to enable it to establish a connection from a stranded ship to the shore.
7. It should preferably have an effective wireless equipment thoroughly protected.

The first feature is of particular importance, as a boat that is practically non-capsizable is the safest boat, even under the worst conditions of the sea, whereas a power boat designed as a self-righting boat does not insure absolute safety against capsizing. If a self-righting boat capsizes, even though it rights itself, and is still of use, yet it is problematical if in a very rough sea the occupants of the boat could save themselves unless they were expert swimmers. The uncapsizable feature, therefore, seems more favorable than any self-righting qualities that might be incorporated.

Seaworthiness, of course, is absolutely necessary, and by seaworthiness is meant the ability of the boat to stand almost any sea and to be readily maneuvered in the heaviest weather. To be thoroughly seaworthy the boat must have positive and sufficient self-bailing qualities to relieve itself quickly of any water that might rush in and at the same time to keep as dry a boat as possible. Where used for transporting people from one ship to another, or in rescue work where a ship is stranded, the need for a seaworthy boat is obvious.

The third feature enumerated—that is, the desirability of keeping the height of the boat as low as possible when placed on the deck of a steamship, and also to have as great a carrying capacity as can be consistent with other requirements—is desirable as far as economizing space in stowing boats on board ship is concerned, and it is also of great importance to have the power boat so built that the propellers, or outward parts of the driving mechanism, are sufficiently well protected to obviate the danger of having them damaged when the boats are handled under davits, particularly if the ship is rolling and pitching.

The importance of the fourth feature is obvious, and has been discussed earlier in the article.

The principal advantage in having a certain number of power lifeboats on board passenger ships is the fact that the regular lifeboats can easily be towed by the power boats and kept together until assistance arrives from some other ship. Power lifeboats can also bring other lifeboats under the lee of the rescuing ship. In either case it is important to be able to make connections between the various boats and also to connect with a rescuing ship, which, in a very rough sea, is not so easily done as might be imagined. It is for such work that feature No. 5 should be provided, and probably the best solution of this problem is the provision of one or more reels

of rope on board the power boats, as usually there is not enough rope at hand for towing purposes, and if there is it generally gets twisted and is not in such shape that it can be readily used to the best advantage. If reels of rope are provided the means of connecting the lifeboats together, or connecting to the rescue ship, are readily at hand and instantly available.

The sixth feature needs a little explanation. In the case of a stranded ship it is often found that the distance of such a ship from the shore is too far for the line-carrying guns to reach the shore or vessel. For this reason it would be desirable to have one or more power lifeboats on board the ship equipped with line-carrying guns, so that the power boat can be used as an intermediate station between the wreck and the shore. Such a line-projecting gun would also be useful when it is difficult to make connection with other lifeboats and with the rescue ship.

Wireless equipment, as specified in the seventh feature, must always be in working order to be of any value. So far the difficulties in connection with equipping regular lifeboats with a wireless installation of limited radius have been the impossibility of getting sufficient spread and height for the wires between the masts, and of conveniently housing the operator with the necessary equipment on account of the more or less cramped space that can be obtained on lifeboats. These are difficulties, however, which can be readily overcome. On very large ships, where it is found necessary to carry a great number of power lifeboats, it will probably be found more practicable to carry one power lifeboat on each side of the vessel with suitable wireless equipment.

In view of the importance of the installation of power lifeboats on board passenger ships and the special requirements which such boats must fulfil, both their design and the arrangements for their installation should be made the subject of careful study. In Figs. 1, 2 and 3 are shown plans of a new power lifeboat designed by Captain A. P. Lundin, of the Welin Marine Equipment Company, Long Island City, N. Y.

As can be seen from the illustrations the boat is really a development of the standard Lundin decked lifeboat, which was described on page 252 of our June, 1912, issue. The power boat is provided with a tunnel stern so that the propeller is entirely above the bottom and well protected in the tunnel. The bottom of the hull is absolutely flat; but by a special construction adopted in all types of Lundin lifeboats it is of very great structural strength. The ends are raised, the stern round, the bow being somewhat pointed and shaped off, while the sides are flat. A watertight metal deck is fitted so that the lowest point of the deck is at least 5 inches above the load waterline. The space underneath this deck is subdivided into seven watertight compartments, each fitted with a raised manhole. Thwarts and side benches are fitted on top of the fixed gunwale. The sides above the thwarts are made of wood, and one arrangement is provided with the sides folding to allow nesting and the other with stationary sides. The folding sides are easily raised, and held in position by means of self-locking slides and special corner locks. Smaller boards are fitted athwartships a few feet from each end of the boat, and a couple of rowlocks are provided on each side.

Several small and large sluices are fitted in suitable places through the bottom of the boat, making the boat self-bailing. These sluices are of a special design; the slanting valve is placed beneath the inner bottom, reaching almost down to the load-waterline, with a reservoir to take care of the incoming water, thus making the bailing very effective. The water rushing in through the lower part of the scupper pipe is led in a direction so as to increase the closing pressure of the valve. The valves themselves are placed athwartships, thus making them least affected by the rolling of the boat. This arrangement, it is claimed, gives an unusually dry boat.

Against the flat of each side of the hull is secured a fender,

which serves as a protection to the boat and gives additional stability, at the same time shaping out the boat. The two fenders are made of Balsa wood, and are specially prepared so as to make them waterproof. They are covered with heavy canvas, and outside of this with heavy wire cloth, thus making them almost indestructible. They are clamped to the sides of the hull in such a way that they are easily removable for inspection or painting of fenders and hull.

The engine is placed in a watertight trunk with easily detachable covers. Large fuel tanks are placed in the watertight compartment forward of the engine trunk, and are thus beyond reach, out of danger of being hampered with, but at the same time easily accessible when repairs are needed. To improve the maneuvering qualities of the boat in a rough sea a double fin is placed in the forward part of the tunnel. The fin is positively controlled by a gear and screw arrangement, and is designed to make the least resistance in the water, but at the same time is very strongly built, so as to withstand a great side pressure.

The boat with folding sides (Fig. 2) is provided with a folding reel, and the other boat (Fig. 1) with two stationary reels. The boats will in this way be fitted out with at least 1,000 feet or more of good, strong rope conveniently handled. In the bow and the stern of the boat, towing hooks are provided. These hooks are easily handled by means of a special arrangement by which the hook can be made stationary in an upright position. A line-carrying gun with three faking boxes is provided on the boat with stationary sides, and the other boat can be fitted out with a line-carrying shoulder gun.

The boats are equipped with tall masts, and by making them slanting it will be possible to get a length of some 50 feet for the wires on a 36-foot boat, which, of course, means a comparatively big working radius for the wireless. A wireless house is provided on the boat shown in Fig. 1, thus enabling the operator to work without being disturbed in any way. On the boat shown in Fig. 2 the operator will have at his disposal a special arranged working box on the aft deck, so he will be altogether out of the way, and will not be hampered in his operations by the people in the boat. The necessary power for the wireless is furnished by the engine, and the working radius of the wireless would probably be something between 75 and 150 miles, and could be greatly increased by the use of a kit.

As a whole the Lundin decked power lifeboat represents a logical development based upon a wide experience in the building of lifeboats and the construction of tunnel-stern, shallow-draft power boats, two types of craft which combined produce a boat admirably suited to fulfil all reasonable requirements for a successful power lifeboat.

INTERNATIONAL ENGINEERING CONGRESS, 1915.—In connection with the Panama-Pacific International Exposition, which will be held in San Francisco in 1915, there will be an International Engineering Congress in which engineers throughout the world will be invited to participate. The congress will be conducted under the auspices of the five leading American engineering societies.

SHIPBUILDING ACTIVITIES IN AUSTRALIA.—According to press reports, Australia proposes to establish new shipbuilding yards at Jervis Bay, for the construction during the next three years for the Royal Australian navy, of one battleship, three destroyers, two submarines and a supply ship.

MONTHLY SHIPBUILDING RETURNS IN THE UNITED STATES.—The Bureau of Navigation reports 167 sailing, steam and unrigged vessels of 45,397 gross tons built in the United States and officially numbered during the month of April. Forty percent were steel steamships built on the Atlantic coast. The largest vessel built was the *Montanan*, of 6,649 gross tons, constructed by the Maryland Steel Company, Sparrows Point, Md., for the American-Hawaiian Steamship Company, New York.

The Motor Ship Siam

The motor liner *Siam*, built by Burmeister & Wain, Copenhagen, for the East Asiatic Company, carried out her trials successfully on April 8. The principal dimensions of the motor ship are: Length, 410 feet; breadth, 55 feet; depth to main deck, 30 feet 6 inches; depth to awning deck, 38 feet 6 inches; draft, 26 feet 6 inches; displacement, 13,200 tons; deadweight carrying capacity, 9,500 tons; capacity of holds, 500,000 cubic feet. The vessel is equipped with two Burmeister & Wain Diesel engines of the four-cycle, eight-cylinder type, developing in all 3,000 horsepower. During the trial trip the fuel consumption amounted to 153 grammes per horsepower-hour, including the main and all auxiliary machinery. A speed of 12.4 knots was obtained.

Besides the main Diesel engines there are two auxiliary Diesel engines installed in the engine room, each of 300 horsepower, coupled to a dynamo and a compressor. The dynamo is large enough so that while running at sea sufficient current is produced to supply all the auxiliary machinery, including the steering engine, as well as for lighting the vessel. When lying in harbor the electric current is used for working the deck winches, which are electrically driven. These winches were supplied by Messrs. Siemens & Schuckert, Berlin.

At the conclusion of the trial trip the vessel was taken over by the owners and taken at once to the Freeport, where she took on cargo and commenced her first voyage, calling at Aalborg, Gothenburg and Antwerp for additional cargo, and then proceeding through the Mediterranean and the Suez Canal to Singapore, where her double bottom will be filled with fuel oil, and then she will leave for China and Japan, finally arriving at Vladivostok, whence she will return to Copenhagen. This undoubtedly will be the longest voyage which has yet been undertaken by a motor liner.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

		BATTLESHIPS			
	Tons.	Knots.		Feb. 1.	May 1.
New York.....	28,000	21	Navy Yard, New York.....	69.6	77.2
Texas.....	28,000	21	Newport News Shipb'g Co.....	84.3	88.4
Nevada.....	28,000	20½	Fore River Shipb'g Co.....	19.6	29.3
Oklahoma.....	28,000	20½	New York Shipb'g.....	14.9	26.0
		TORPEDO BOAT DESTROYERS			
Cassin.....	742	29½	Bath Iron Works.....	77.5	87.2
Cummings.....	742	29½	Bath Iron Works.....	68.5	81.2
Downes.....	742	29½	New York Shipb'g Co.....	37.1	47.5
Duncan.....	742	29½	Fore River Shipb'g Co.....	63.0	79.0
Aylwin.....	742	29½	Wm. Cramp & Sons.....	83.5	92.1
Parker.....	742	29½	Wm. Cramp & Sons.....	77.9	89.2
Benham.....	742	29½	Wm. Cramp & Sons.....	72.4	87.9
Balch.....	742	29½	Wm. Cramp & Sons.....	81.1	88.5
O'Brien.....	742	29½	Wm. Cramp & Sons.....	00.0	1.3
Nicholson.....	742	29½	Wm. Cramp & Sons.....	00.0	1.2
Winslow.....	742	29½	Wm. Cramp & Sons.....	00.0	1.2
McDougal.....	742	29½	Bath Iron Works.....	00.0	4.4
Cushing.....	742	29½	Fore River Shipb'g Co.....	00.0	8.9
Ericsson.....	742	29½	New York Shipb'g Co.....	00.0	5.0
		SUBMARINE TORPEDO BOATS			
F-4.....	.....	.....	Seattle Con. & D. D. Co.....	94.6	100.0
G-4.....	.....	.....	Wm. Cramp & Sons.....	88.3	88.4
G-2.....	.....	.....	Newport News Shipb'g Co.....	86.0	87.2
H-1.....	.....	.....	Union Iron Works.....	87.2	90.4
H-2.....	.....	.....	Union Iron Works.....	86.7	90.0
H-3.....	.....	.....	Seattle Con. & D. D. Co.....	84.9	88.0
G-3.....	.....	.....	Lake T. B. Co.....	61.9	67.4
K-1.....	.....	.....	Fore River Shipb'g Co.....	65.5	76.6
K-2.....	.....	.....	Fore River Shipb'g Co.....	65.3	76.8
K-3.....	.....	.....	Union Iron Works.....	68.1	75.6
K-4.....	.....	.....	Seattle Con. & D. D. Co.....	66.1	75.0
K-5.....	.....	.....	Fore River Shipb'g Co.....	48.5	58.7
K-6.....	.....	.....	Fore River Shipb'g Co.....	48.5	57.1
K-7.....	.....	.....	Union Iron Works.....	55.6	65.3
K-8.....	.....	.....	Union Iron Works.....	54.1	63.4
		COLLIERS			
Proteus.....	20,000	14	Newport News Shipb'g Co.....	80.4	90.7
Nereus.....	20,000	14	Newport News Shipb'g Co.....	72.1	87.1
Jason.....	20,000	14	Maryland Steel Co.....	87.2	98.8
Jupiter.....	20,000	14	Navy Yard, Mare Island...	92.5	99.1

Side-Wheel Passenger Steamer See-and-Bee

The new side-wheel passenger steamer *See-and-Bee*, built for the Cleveland & Buffalo Transit Company, Cleveland, Ohio, at the Wyandotte yard of the Detroit Ship Building Company, was launched Nov. 9, 1912, and will be ready July 1 for daily service between Cleveland and Buffalo. The vessel, designed by Frank E. Kirby, is not only the largest side-wheel passenger steamer on the Great Lakes, but is also the largest side-wheeler in the world. Her construction marks a notable achievement in naval architecture for this class of vessel, and establishes a standard that it is quite unlikely will be exceeded for a long time to come. The steamer is of the following dimensions:

Length over all.....	500 feet.
Length between perpendiculars.....	485 feet.
Beam of hull, molded.....	58 feet.

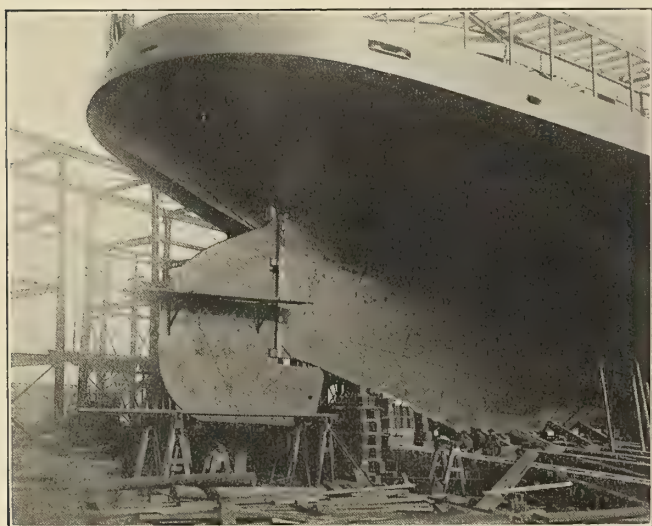


FIG. 1.—STERN OF HULL

Extreme beam over guards.....	97 feet 8 inches.
Depth of hull at stem.....	30 feet 4 inches.
Depth of hull at stern.....	27 feet 1 inch.
Depth of hull, molded.....	23 feet 6 inches.
Depth of hull at guards.....	22 feet 10 inches.

Her guaranteed speed is 22 miles per hour from dock to dock, and to make it she has been equipped with propelling machinery developing 12,000 horsepower.

There are 62 staterooms fitted with private toilet connections, 424 regulation staterooms and 24 parlors *en suite* with private bath and toilet, making a total of 510 rooms. She has therefore sleeping accommodations for 1,500 persons, and will carry about 6,000 passengers, the population of quite a respectable sized town. Her freight capacity is 1,500 tons, carried exclusively on the main deck for convenience of handling.

DECORATIVE FEATURES

The keynote of the decorative scheme, worked out by Louis O. Keil, is a rich simplicity. The first thing that the traveler sees, of course, about a steamer is the lobby. This is very spacious, containing the purser's and steward's offices, telephone booths, parcel and baggage rooms, and a lunch counter, the entrance of which is gained through a doorway. The lobby is designed in the Tuscan order of architecture. The walls are paneled in mahogany inlaid with various woods, and the colors are in keeping with the general dominant tone of this aristocrat of woods. The ceiling decorations are in

bronze and Roman verd. A feature of the lobby that marks quite a departure from the usual sidewheelers on the lakes is that the grand stairway leading to the promenade deck is enclosed in a vestibule with sliding doors. The purpose of this is to shut the stairway off immediately if occasion requires.

The main dining room is immediately abaft the purser's and steward's offices, on the main deck, extending to the stern of the ship. It is carried out in Adams design with mahogany and white enamel. In addition to a banquet room 24 feet long on the starboard side and two private dining rooms on the port side, there are a number of alcoves with bay windows on both port and starboard sides of the main room, where one may have a fair degree of privacy in dining. Light is obtained from Sheffield silver candelabra carried on columns,



FIG. 2.—BOW RUDDER

as well as Sheffield silver wall brackets. The extreme outer end of the main dining room is taken up with a great side-board with dumb waiter leading to the buffet on the orlop deck below. The location of the dining room on the main deck is a happy one, as it permits the passenger to look out over the waters as the boat speeds along.

The buffet, as stated, is directly under the dining room, and is approached by a stairway on the main deck aft. It is in tavern design after the manner of an old English inn, and will call to mind the remark of the great Dr. Samuel Johnson that nothing was ever contrived that gave mankind so much creature comfort as a good tavern.

Passing from the lobby to a vestibule and up a wide and handsome flight of stairs one enters the main saloon, upwards of 400 feet long, on the promenade deck, and subdivided for convenience into several sections, having flower booths, a book and periodical store, observation room and ladies' writing room amidships and men's writing room forward. The style of the main saloon is in the Ionic order of architecture, having a wainscot of carefully selected mahogany highly furnished, the upper part finished in fine enamel.

The general color scheme of the gallery deck is gray, ivory and white. At the after end of the gallery deck is the ladies' drawing room of Italian Renaissance design with built-in seats at the after end in walnut. The furniture in this room is of walnut covered in tapestry, and the floor covering of the best Wilton. The room is lighted by ceiling fixtures.

On the upper deck, immediately above the drawing room, is located the atrium, which is a Pompeian court with sleeping rooms adjoining. In the center is an open well looking down upon the drawing room. A balcony for an orchestra is located at the after end of the main saloon, just forward of the ladies' drawing room on the gallery deck above, from which music reaches not only the main saloon but the drawing room and atrium on the upper decks as well.

Probably the most popular feature of the ship will be the lounge on the upper gallery deck amidships. It will be con-

character of the wood finish. Each parlor contains twin brass beds, a divan, tables, dressers, chairs, mirrors and plenty of cushions to lend an air of comfort. Private baths, finished in pure white enamel, and private balconies complete the equipment of these parlor suites.

HULL STRUCTURE

The hull is constructed entirely of steel, having a double bottom for water ballast extending for a length of about 365 feet, and having a depth of of 3 feet above the base line. This



FIG. 3.—THE ATRIUM



FIG. 5.—MAIN SALOON



FIG. 4.—THE LOUNGE



FIG. 6.—MAIN DINING ROOM

ventional in design, finished in fumed oak, and the decorative features in L'Art Nouveau are painted directly on the wood. The stack casing which penetrates this room is decorated by panel paintings. This room may also be reached by a forward stairway leading from the promenade deck between the stacks to the upper deck. An air of comfort and coziness is imparted to the lounge by numerous little bays on both the port and starboard sides, where light refreshments are served from a counter built-in at the after end of the lounge. The floor is covered with asbestolith.

Bordering the main saloon are a number of parlors, the principal ones being named by courtesy in honor of the president, general manager, traffic manager and directors of the company. Each room is of different design, being finished in either vermilion wood, satin wood, mahogany, red gum wood, silver gray maple, prima vera and enamel. The furniture and decorations of each of these parlors is in keeping with the

double bottom is divided at the center line by a fore-and-aft watertight girder, and is further subdivided by transverse bulkheads into fourteen separate watertight compartments. The hull above the water bottom is divided by eleven athwartship watertight bulkheads extending from the keel to the main deck. These watertight bulkheads, with the exception of the collision bulkhead and other bulkheads that are required by law to be without openings, are fitted with watertight doors operated hydraulically from the engine room.

Including the tank top there are seven decks in all, namely, the orlop deck, main deck, promenade deck, gallery deck, upper deck and dome deck.

Steel is used to a greater extent in the structure of this ship than in any other of her type, being carried to the

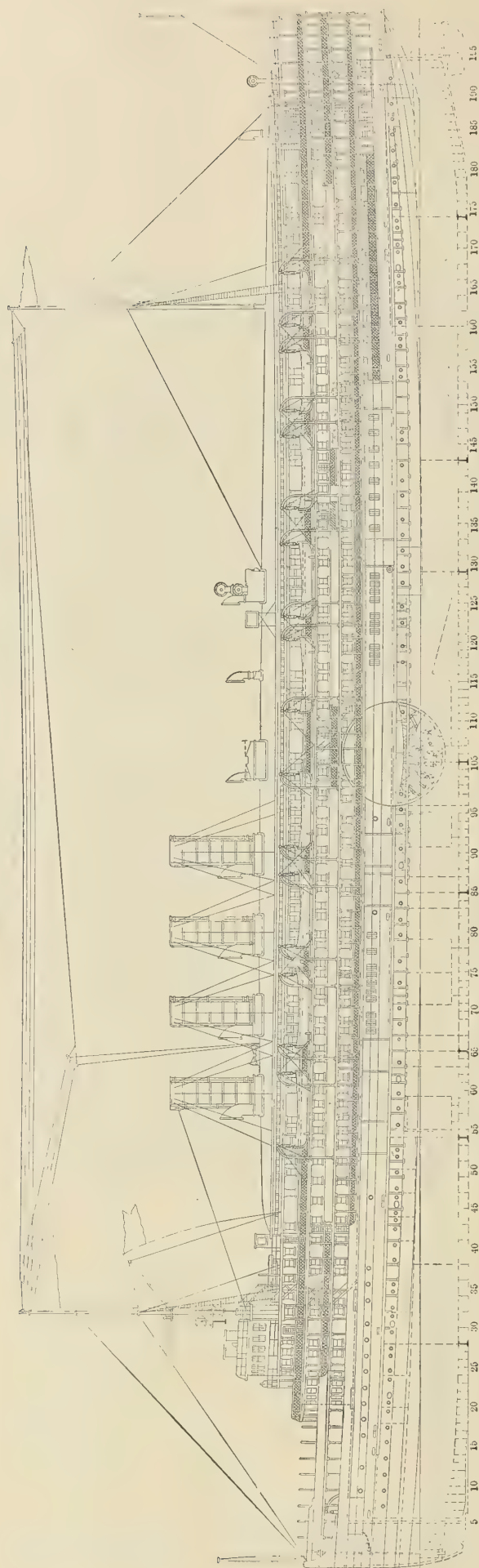


FIG. 7.—OUTBOARD PROFILE OF THE SEE-AND-BEE

promenade deck. The housings on the orlop and main decks and top sides to the promenade deck are of steel. The top sides of the promenade deck are finished with a channel gutter, forming a landing for the promenade deck beams. The beams and the underside of the promenade deck are sheathed with galvanized iron with heavy asbestos paper. This with the steel housings up to the promenade deck makes the vessel practically fireproof. Moreover, the engine room, boiler room and galley, ventilators and inclosures are all of steel, and extend from the main deck through the top of the dome. Fireproof doors are also fitted extending from the main deck through all decks to the dome, dividing the vessel into three separate compartments.

In addition to the three great divisions the boat is divided into fifty sections for fire alarm purposes, each section containing about eight staterooms, and by means of a very ingenious device of hollow wire with which each stateroom is equipped, any disturbance will be immediately registered upon an annunciator located in the engine room and in the captain's quarters.

The crew's quarters are built of steel throughout. Steel fire curtains are fitted in cargo spaces opposite engine room inclosures. Fire hydrants are located throughout the vessel, so spaced that 50-foot lengths of hose connected at all times reach every part of the vessel.

There is also a very complete automatic sprinkler system throughout the interior of the ship, covering all cargo holds, crew's spaces, hallways and cabins, smoking room, lounge room, and other service rooms of the ship. This system is controlled automatically by a special sprinkler pump located in the engine room. When the vessel is docked connections are also made whereby city protection for fire purposes can be immediately used.

There are two trimming tanks, each of about 52 tons capacity, located on both port and starboard sides just aft of the wheel casings. These tanks can be either filled or emptied in from two to four minutes, thus making it possible to keep the vessel always on an even keel.

To facilitate quick handling in rivers and harbors, the steamer is fitted with a bow rudder, which is controlled by a steam steering engine located on the main deck forward and directly connected to rudder stock by chain and quadrant. The character of the service is such that the vessel has to navigate restricted and somewhat tortuous channels at both Buffalo and Cleveland, and the bow rudder makes her instantly responsive and manageable. The after rudder is controlled by a steam steering engine connected to quadrant by a chain. Emergency steam steering gear is also provided should anything go wrong at any time with the after rudder.

The life-saving appliances of the vessel are in accordance with Government requirements, there being eighteen metallic lifeboats, all of special design, fourteen of these having a capacity for forty persons each, two having a capacity for twenty persons each, and two for sixteen persons each. In addition the vessel is equipped with the usual number of life rafts and life preservers, as required by the United States Steamboat Inspection Service.

The second class cabins, both for men and women, are built entirely of steel, and are located on the main deck forward of the lobby.

Great attention has been paid to the ventilation of the ship, which is equipped with the latest type of McCreery Engineering Company's washed air system of ventilation, reaching all inside staterooms, dining rooms, buffet, smoke-room, galley and crew's spaces. This system of ventilation is also directly connected to all lavatories and toilet rooms throughout the ship, and is divided into five units, as follows: One unit forward in the hold will supply the crew's quarters for that end of the ship; one unit in the hold directly aft of

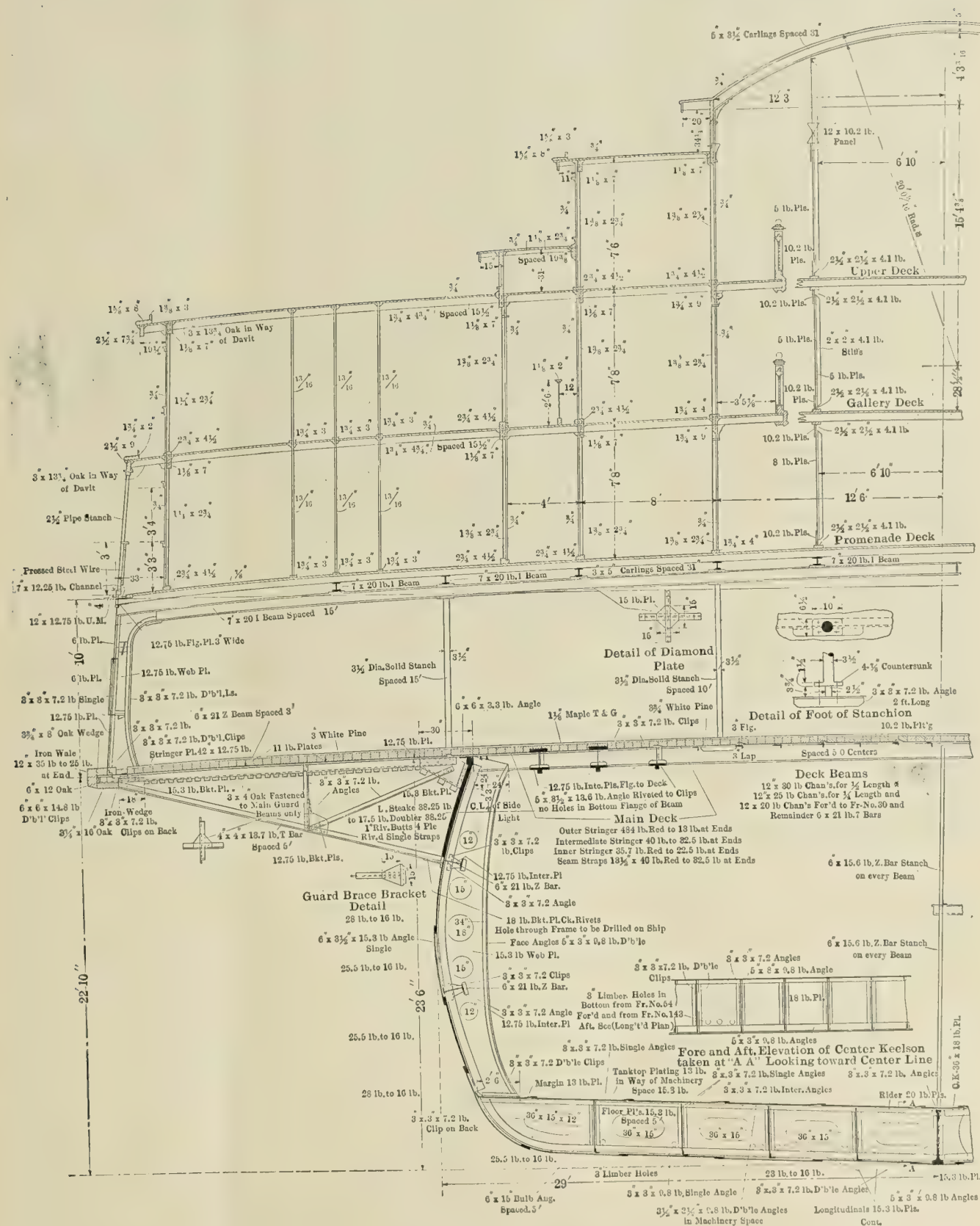


FIG. 8.—MIDSHIP SECTION

the engine room will supply the crew's quarters aft and the galley; one unit located on the orlop deck aft will supply the dining room and two units on the main deck, port and starboard will supply all the staterooms, the baggage room, the telephone room and second class deck cabins.

These units consist of a McCreery air washer built of heavy sheet copper with brass angle and brass pipe work. A Sirocco fan direct connected to an electric motor draws the air through a washer and distributes it through the duct work. The spray in the washer is maintained by a centrifugal pump direct connected to an electric motor. Throughout the crew's quarters and galley adjustable elbows are used for distributing the air, making it possible to deliver the air in any desired direction. The air in the staterooms is introduced underneath the lower berths in such a manner and in such velocity that no draft is felt in any part of the room. The lower berth is kept out from the wall at least an inch, so that the

having a large receiver built of plate steel directly overhead. The estimated indicated horsepower is 12,000 at 31 revolutions per minute. Practically the entire engine is under the main deck, only the tops of the main bearings, the upper part of some of the valve gear and the handling levers projecting above the level of the deck. The high-pressure cylinder is 66 inches in diameter, and is placed between the two 96-inch diameter low-pressure cylinders, all having a common piston stroke of 9 feet.

All the cylinders were molded on end in loam molds. The open end was cast down, this being the usual practice of the makers. The mold was parted on the center line of the steam chests, also in the center line of the cylinder, and drawbacks were made on the upper steam chests. These partings were made to enable setting of the cores with greater accuracy. The radial cores for the crank end of the cylinders were suspended from the top plate of the mold and the center of main



FIG. 9.—MAIN ENGINE ON ERECTING FLOOR OF BUILDER'S SHOP

air flows directly upwards entirely around both berths. A space between two carlines is closed off, and is provided with a hinged door at both the side wall of the inside staterooms and the outside of the cabins. This provides a natural exhaust from the rooms to the outside of the ship.

The heat generated in the galley and the foul air from the crew's quarters aft are removed by a large Sirocco fan located in the galley vent and connected to the spaces to be ventilated by means of duct work. Approximately 60 horsepower is used for the ventilating system. The local vents from all the toilet fixtures throughout the ship are connected by means of duct work with aspirating tubes in two of the stacks, thus maintaining a positive exhaust of considerable suction on all these fixtures, so that no possible odors escape into the ship. This is a very important feature, as a large number of toilet fixtures are installed with parlors and semi-parlors.

PROPELLING MACHINERY

The propelling engine is of the inclined, three-cylinder, compound jet condensing type, installed in a compartment by itself immediately aft of the boilers, having one high-pressure and two low-pressure cylinders, each low-pressure cylinder

core was put in place last. The contract called for 30,000 pounds tensile strength, but all test bars showed better than the requirements. The rough castings of one low-pressure cylinder weighs 65,760 pounds, and the other 67,200 pounds. The high-pressure cylinder weighs 54,000 pounds.

The high-pressure cylinder is fitted with poppet valves and Sickles cut-off gear, while the low-pressure cylinders have Corliss valve and gear. The valves are all operated by the Walschaert gear so familiar on locomotives. This, in combination with the poppet gear on high-pressure and the Corliss on the low-pressures, is unique in marine design. The principal reason for adopting this gear was the desirability of one eccentric on the main shaft for each cylinder and the advantage of short eccentric rods, also that the links take up less head room. The cut-off in each cylinder has a range of from one-fourth to three-fourths of the stroke, adjustable from the starting platform.

None of the cylinders is steam jacketed, but, together with the two large tank receivers, all are well insulated. The pistons are of cast steel, conical and of single thickness, and are fitted with cast iron spring and junk rings. The piston rods, crossheads, connecting rods, guide struts and crankshaft

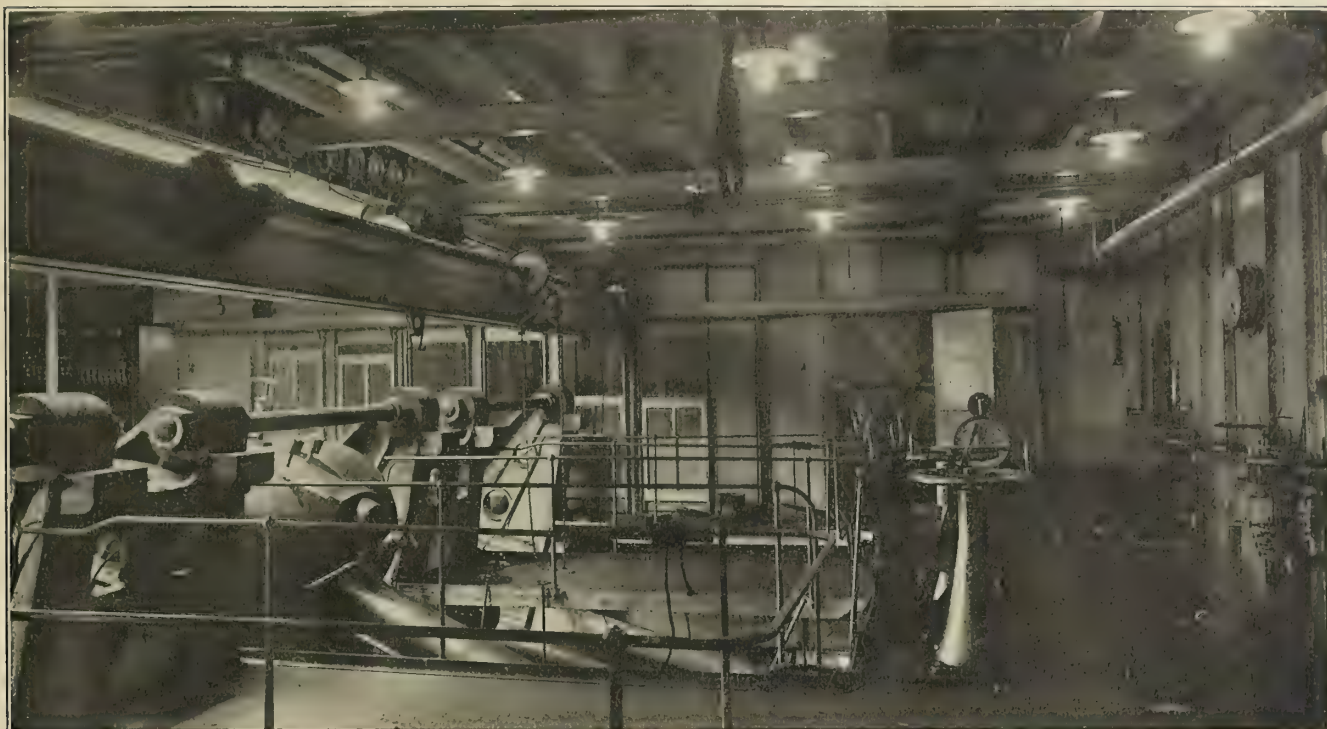


FIG. 10.—VIEW IN ENGINE ROOM, SHOWING STARTING PLATFORM

are all of the highest quality steel forgings, supplied by the Midvale Steel Company. The crankshaft is $26\frac{3}{4}$ inches in diameter in the engine bearings and $30\frac{3}{4}$ inches in diameter at the outer bearings, 78 feet 4 inches long from end to end,

and weighs 120 tons, and is of carbon steel, hollow forged. It is made in three sections, connected by flanged couplings, which are recessed into the hubs of the crank arms. The crank arms are sunk into the pins, thus making the crank-

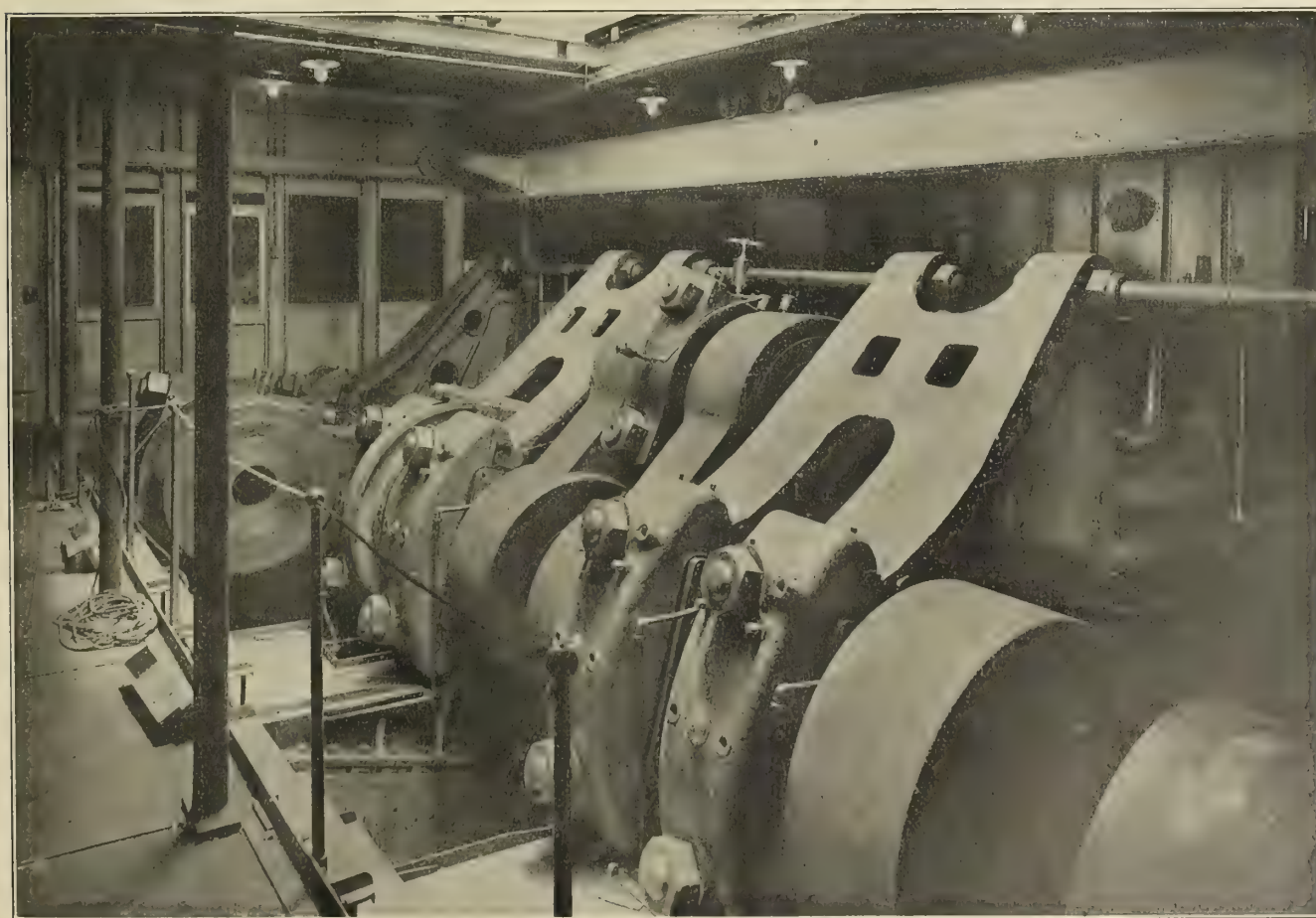


FIG. 11.—MAIN ENGINE CRANKSHAFT AND PILLOW BLOCKS

shaft perfectly rigid from end to end, and avoiding all the trouble incidental to loose pins, wedges, etc. The crank-shafting and pins are hollow throughout.

The connecting rods are 21 feet 2 inches center to center, and 15 inches in diameter at the center of their length, and are nickel steel. Each connecting rod weighs approximately 12 tons. The piston rods are 12½ inches diameter, and the crosshead slippers are steel castings faced with white metal. The main bearing pedestals, six in number, are massive steel castings, rigidly bolted to the foundations, which are part of the ship structure, and braced together to insure stiffness when the engine is working. The guide struts are connected to the main bearing castings by a T-end, through which the main bearing bolts are extended, and to the cylinder by round flanges and bolts. Midway in their length they are supported by vertical columns carried from the ship's floors. Each cylinder, as stated, is cast complete with its valve chests, thus avoiding all unnecessary and oftentimes troublesome joints. The front heads are also cast with the cylinders, and are strongly ribbed to distribute the strain from the guide struts. The finished low-pressure cylinders weigh 33 tons each, and are excellent specimens of the founder's art.

The main air pumps, 62 inches diameter by 41½ inches stroke, two in number, are of the vertical, single-acting plunger and bucket type, driven through heavy forged steel bell crank levers from the low-pressure crossheads. Each air pump crosshead also carries the plunger of a single-acting vertical feed pump, 8 inches by 41½ inches, and bilge pump 7 inches by 41½ inches.

The condensers are built up of riveted plate, and each low-pressure cylinder connects with its own condenser through a 24-inch exhaust pipe.

The reversing of the engines is accomplished by means of a direct-acting steam gear, but a powerful hand-operated worm reversing gear is fitted for emergency use.

The handling gear levers are all conveniently grouped in a quadrant on the working platform above the cylinders, and massive though the moving parts are the reversing, etc., is accomplished with the greatest ease and facility. The main throttle valve, 18 inches in diameter, is of the Schuette-Koerting balanced type, operated by a simple lever, and is fitted with an 8-inch "by-pass," or maneuvering valve, which is sufficiently large to operate the engine up to half speed. The lubricating system is elaborate and complete, as are the appliances to assist in the overhauling or lifting of the engine parts. The paddle-wheels are unusually strong and heavy. The centers are of cast steel and the arms of forged iron, with the large gudgeon bosses forged on and bushed with lignum-vitæ. The wheels are 32 feet 9 inches diameter, each fitted with eleven curved steel buckets, 14 feet 10 inches long by 5 feet wide. The radius rods are of forged steel fitted with brass bushings. The outboard bearings are heavy steel castings, lined with white metal, and are adjustable in vertical and fore-and-aft directions.

BOILERS

Steam at 165 pounds per square inch pressure is supplied by six single-ended and three double-ended Scotch boilers. The single-ended boilers are made up of two shell plates, and are 14 feet inside diameter by 10 feet 6 inches over head, and each contains two 54-inch inside diameter Morison plain-end furnaces; the tubes are 2¾ inches outside diameter. The double-ended boilers are made up of only four shell plates, and are 14 feet 2 3/16 inches mean diameter by 20 feet 5½ inches over-heads, and each containing four 54-inch inside diameter Morison suspension plain-end furnaces. The tubes are 2¾ inches outside diameter. The grate bars are all 5 feet 6 inches long and designed for Howden draft. The boilers are

placed in three batteries of three each, and are fired in the fore-and-aft direction, the coal being carried in two large bunkers athwartship, this arrangement making four distinct fire rooms. The bunkers are so placed that the coal is practically self-trimming onto the fire doors directly in front of the fires, practically eliminating coal passing. Bennett flue blowers are installed in all boilers.

There are four funnels, with outer casings fitted up to the level of the top deck and single above. The stack, forward, is fitted with one 10-inch by 36-inch whistle and one 6-inch organ whistle.

The ashes are discharged outboard by eight hydraulic double-jet ash ejectors of improved design. The stokeholds are roomy and well ventilated, and designed with safety escapes and with a view of comfort for the stokers.

ELECTRICAL EQUIPMENT

Altogether there are 4,500 electric lights aboard the ship. Practically every function that can be is performed by electricity. The generating sets consist of three turbine engines direct connected to dynamos, and along with the main switchboard are located in the engine room on the main deck. The boat is wired throughout with the new National Board of Underwriters' marine core wire, and the conduits for carrying the wire are of galvaduct. The main switchboard is equipped with automatic circuit breakers and also double-throw switches, so that all power can be put on any one dynamo should it be necessary. All fuses in the switchboard and distributing boards are of the 250-volt National code type. The circuits are so arranged that the electrician can disconnect any number and combinations of lights, still leaving light enough to get around. This is convenient, of course, for the night lighting of the ship when fewer lights are required.

The telephone system is in full equipment exactly similar to a system in vogue in cities, having motor generator for calling and a central storage battery for talking. There are over 500 telephones on the boat, one in every stateroom, as well as in the officers' quarters and in the telephone booths, with the main switchboard in social hall. In addition, of course, to this public telephone system, there is a private system for the operation of the ship leading from the pilot house to the engine room and other departments.

The steamer is, of course, equipped with wireless and also carries an auxiliary storage battery plant, which will operate for six hours if by any accident the boilers should be put out of commission. Alarm boxes are placed at convenient intervals, which are rung at stated times by the night patrol and register in the pilot house.

An automatic signal board placed in the pilot house controls the signal lights of the ship. These lamps are carried in duplicate, one dormant and the other burning, and if by any chance the burning light goes out the other is automatically thrown in and registers in the pilot house. Assurance is therefore given that the port and starboard and other signal lights are always burning, or at any rate that if anything is wrong with them it is immediately announced.

In addition to the usual engine telegraph the means of communicating intelligence from the pilot house to the engine room are many, including an electric signal bell system and also an electric indicator connected with the main shaft, which indicates whether the engines are going forward or astern. The system of electric fans throughout the boat is quite complete and is especially elaborate and painstaking in the dining room. All the drinking water is passed through copper tubes and purified by electricity before being served. Many of the functions of the galley are also performed by electricity. A 32-inch searchlight, the largest on the Lakes, is provided.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER IX (Continued)

"The bed-plate is the part of the engine which supports the weight of the entire structure, and also forms the seating for the crankshaft or main bearings. They are usually made of cast iron and sometimes of cast steel, and consist of a series of athwartship girders, one under each crankshaft bearing, all being joined by fore-and-aft girders, one on each side. Naturally, they are made as heavy and substantial as possible. The

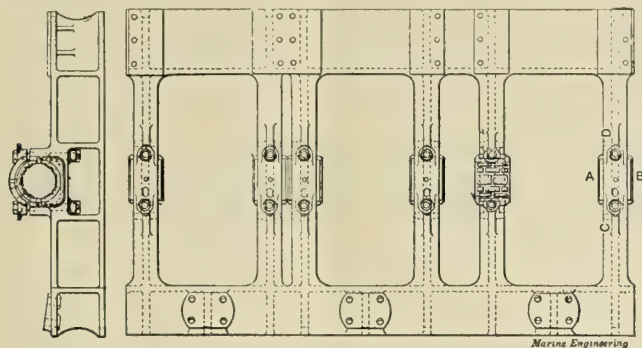


FIG. 10.—BEDPLATE FOR TRIPLE-EXPANSION ENGINE IN ONE CASTING

bed-plate is secured to the foundation, an integral part of the ship's structure, by means of holding-down bolts. Fig. 10 will show you an ordinary type of bed-plate and Fig. 11 a main bearing, or 'pillow block,' as it is sometimes called.

"The main bearing shown in this sketch is such as used for small engines. On larger engines the bottom brass and the cap or binder, as the top bearing is called, are usually cored to

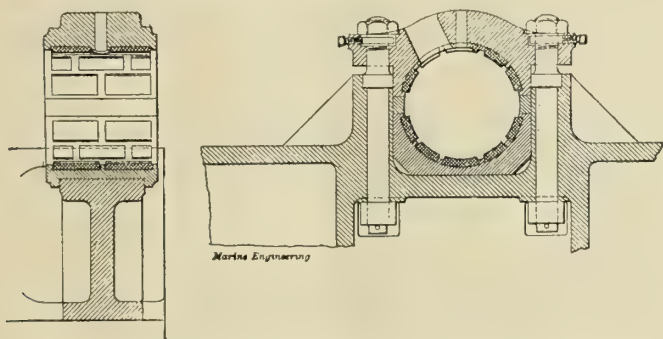


FIG. 11.—DETAILS OF BEDPLATE IN FIG. 10. SECTIONS SHOWING MAIN PILLOW BLOCK

allow for the circulation of sea water in order to prevent the bearing from becoming unduly heated when the engine is run at full speed. All main bearings are lined with Babbitt or other anti-friction metal to reduce the friction."

CHAPTER X

Valves and Valve Gear

"Having gone over the principal parts of the engine, we will now take up some of the minor parts, the principal one of which is the valve gear.

"It is highly important to allow the steam to enter the cylinder at the right time, and it is equally as important to let it out at the right time. These operations must necessarily be performed automatically. The story is told that in the first engine built by James Watt, which was, of course, a very crude affair, he had not progressed far enough in his design

to have the valve operated by the engine itself, and, in consequence, a boy was employed to lift the valve and close it at about as near the proper time as his limited training and judgment would allow. Evidently tiring of such monotonous employment, and being of an ingenious turn of mind, he noticed that a certain part of the engine mechanism had about the same motion which he imparted to the valve and at about the same time. Consequently, as the story goes, he tied a stout piece of cord to the valve lever and connected it to the part of the engine which had the coincident motion, whereupon the valve was actuated automatically, and the boy was found by his employer out in the yard playing marbles, civilization having not advanced sufficiently far at that remote period to permit of the youngster indulging in the more scientific game of shooting craps.

"That boy unconsciously formed the first valve gear ever put on an engine, but since his time there has been considerable improvement in the method of actuating valves. Before

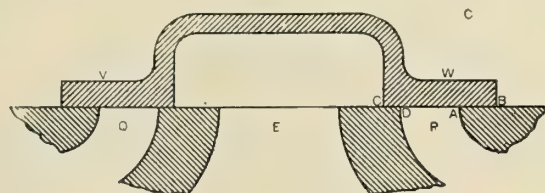


FIG. 12.—PLAIN SLIDE VALVE, MID-POSITION

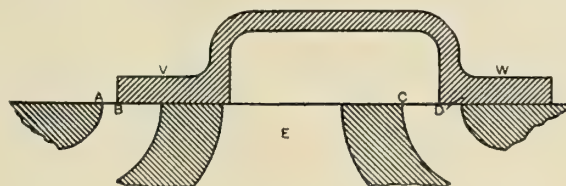


FIG. 13.—PLAIN SLIDE VALVE, POSITION FOR END OF STROKE

describing any methods for moving the valve, you had first better be given an idea of the valve itself. There are a number of different kinds of valves used on stationary engines, but for marine engines there is practically but one type used, and that is known as the slide valve.

"There are two principal types of slide valve: the flat D and the piston valve. The simplest kind of a flat D slide valve is like Fig. 12.

"This valve, by sliding back and forth over the valve seat, alternately admits and releases steam to and from the cylinder which drives the piston up and down. In Fig. 12 the valve is shown in what is known as its mid-position. The amount which the valve overlaps the steam port in this position, *A B*, is known as the 'lap' of the valve, and you must fix that in your memory, as it is frequently referred to by all marine engineers. There are two kinds of lap, as you will notice that on the inside of the valve it also extends over the port the distance *C D*. The outside lap, *A B*, is known as the 'steam lap,' and the inside lap, *C D*, is the 'exhaust lap.'

"In Fig. 13 the valve is shown at the end of its stroke, and you will notice that the valve has opened one of the steam ports on the outside a distance, *A B*; this is known as 'lead,' and there are two kinds of lead also; the outside, or

A B, being known as the 'steam lead,' and the inside, or *C D*, being known as the 'exhaust lead.'"

"Chief, that sounds like horse race dope, the kind I used to hear down at Brighton Beach," said O'Rourke. "I suppose you will be telling us next that the high-pressure valve is in the lead—one lap ahead of the low-pressure."

"No doubt, young man, you know more about horse race dope than you do of anything else; but this is no place for such silly remarks," tartly rejoined McAndrew.

"Why does a valve have this lap?" inquired Nelson.

"There is some sense to a question like that," said the instructor. "Lap is given to a valve so that the steam can be

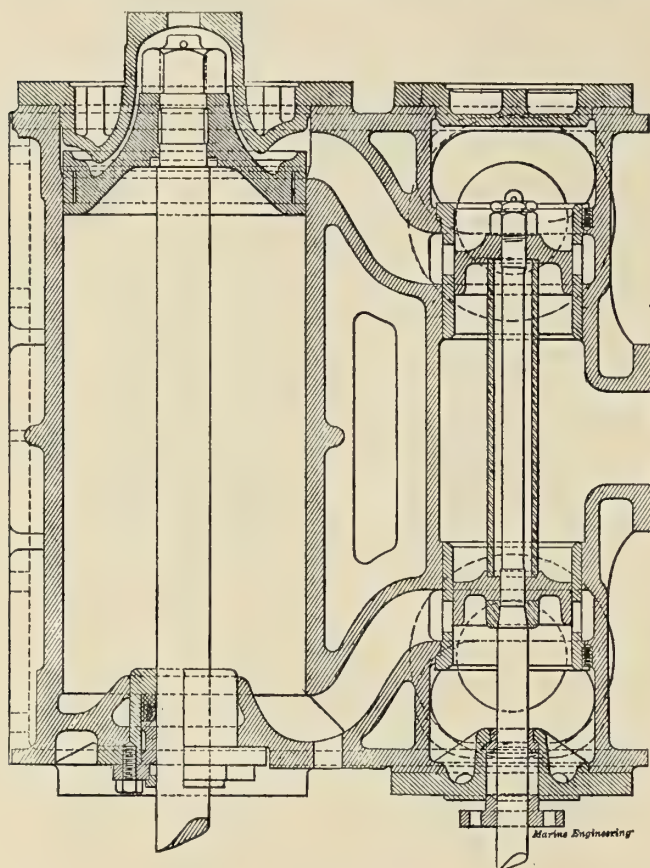


FIG. 14.—PISTON VALVE

cut off at a portion of the stroke and be allowed to expand in the cylinder. If the valve was made the same over-all length as the distance between the outer edges of the two steam ports, live steam from the boiler would be allowed to follow the piston nearly the entire stroke, and we would gain nothing from the expansive effect of the steam.

"As the piston nears the end of its stroke, a certain amount of the exhausting steam in the end of the cylinder towards which the piston is traveling is retained, and as it cannot escape it is compressed and forms a cushion, which overcomes the momentum of the piston, rod, etc. As this is generally insufficient to overcome so much momentum, the live steam for the return stroke is admitted prior to the time when the piston starts on its return. The amount the steam valve is open at the very commencement of the return stroke is, as before stated, known as 'lead,' the purpose of which is to aid in quickly overcoming the momentum of the moving parts and to start the piston back quickly on its return.

"Some old-fashioned simple and compound engines are furnished with a cut-off valve separate, and working upon the back of the regular valve in order to get a sufficient amount of expansion of the steam, but in triple or quadruple-expansion engines we do not need to cut off closely in the high-pressure

cylinder, as there are three or four cylinders in which the expansion may take place. A double-ported slide valve is one used when it is desired to get a very large port opening for a comparatively short valve travel; it is practically one valve within another, and there are two steam ports instead of one in the valve seat; the steam for the outside ports entering over the ends of the valve and the steam for the inner ports coming through passageways in the sides of the valve. On nearly all large cylinders it is found necessary to use these double-ported valves, or otherwise the valve travel would be entirely too great.

"The great disadvantage in using the flat slide valve is the large amount of power consumed in overcoming the friction between the valve and its seat. For instance, a slide valve of ordinary size would be, perhaps, 30 inches long by 42 inches wide, a flat surface of 1,260 square inches. At only 40 pounds pressure per square inch in the steam chest there would be a pressure of over 50,000 pounds pressing the valve against the valve seat. You can readily imagine that the friction caused by moving iron against iron with such a load as that is enormous. Therefore, flat slide valves are not used to any great extent nowadays except in small engines, and then only for the low-pressure cylinder, where the initial pressure of the steam entering the cylinder is usually not over 5 to 10 pounds.

"Some wise old-timer, to get away from using flat slide valves, conceived the idea of wrapping up his slide valve into the form of a cylinder, and thereby removing all unbalanced pressure from the valve while retaining the advantages of the slide valve. Its essential features are two pistons or heads joined by an intermediate distance piece, all being held in place on the valve stem by nuts and washers, as shown in Fig. 14.

"The steam is admitted and exhausted to and from the cylinder by the edges of the valve in precisely the same manner as the flat slide valve. The only disadvantage is the excessive clearance as compared with the flat valve."

"What's clearance, Chief?" remarked Nelson.

"The clearance space in an engine is the volume of the steam ports and passageways between the piston and the bottom and top heads of the cylinder. It would never do to have the moving piston strike the head, either at the bottom or top, for if it did it would knock them off. Consequently there is usually a space of about $\frac{1}{4}$ inch at the top and $\frac{3}{8}$ inch at the bottom, always more at the bottom to allow for the bearings wearing down. These distances are known as the linear clearances, while the entire volume of the space between the piston at the end of its stroke and the cylinder head, plus the volume of the steam passageways, is known as the volumetric clearance. Naturally, as the ports have to reach clear around the piston valve, there is more of this volumetric clearance for this type than there is for a flat valve which lays close up to the cylinder. In modern engine designs this volume is considerably decreased by making the ports straight instead of curved, as shown in the sketch.

"Piston valves can be kept tighter than flat slide valves, for the reason that it is usual to fit the two pistons composing the valve with packing rings similar to those used for the main pistons."

"We have looked into the principal kinds of valves used on marine engines and know what functions they perform, now we want to know what kind of apparatus it is that moves the valves. There are three principal types of operating gear used on marine engines, known by the names of the inventors, respectively, as 'Stephenson,' 'Joy' and 'Marshall.'

"The Stephenson gear is probably used on over 90 percent of the marine engines in use. If ship's engines had to travel in one direction only, the valve mechanism would be comparatively simple, but engines of this kind, as well as those on locomotives, have to be reversed frequently, so it is neces-

sary to have the valve gear designed so that it can go either ahead or back.

"This condition was quite readily solved by Stephenson, one of the first engineers, when he invented his link gear. In this mechanism the fundamental motion is taken from the

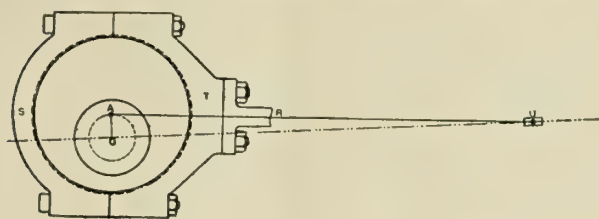


FIG. 15.—PLAIN ECCENTRIC, SKELETON MOTION

crankshaft by means of eccentrics keyed to the shaft. Perhaps O'Rourke can tell us the difference between an eccentric and a crank."

"That's easy," replied the ever-ready. "If a rich man does queer things he is an eccentric, but if a poor man does the same stunts everybody calls him a crank."

"Well, that brings out the idea, anyhow," continued McAndrew. "There is in reality very little theoretical difference between an engine eccentric and a crank, as an eccentric is practically a self-contained crank. The term 'eccentric' means literally 'having different centers,' whereas 'concentric' means having the same centers. Hence it is that the center of the sheave, forming the eccentric, is set off from the center of the shaft upon which it operates, a distance which is known as the 'eccentricity' or 'throw.' The following will illustrate the idea of the eccentric:

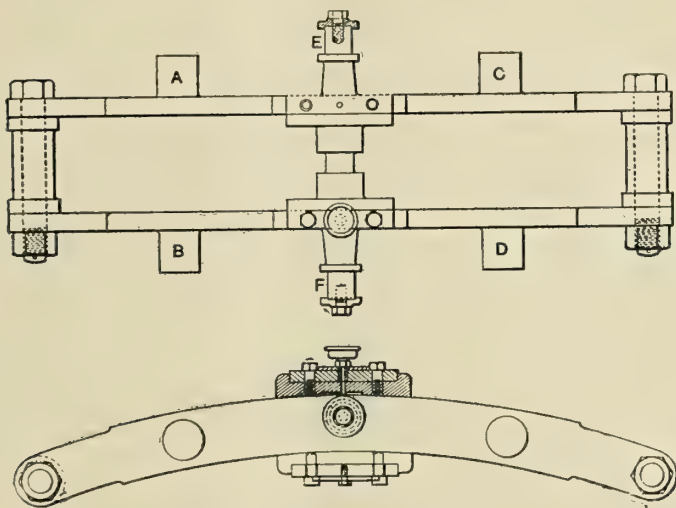


FIG. 16.—STEPHENSON DOUBLE BAR LINK

"The distance AC , Fig. 15, between the center of the shaft and that of the sheave is the throw, and the up-and-down motion imparted to the valve, or the valve travel, as it is known, is double this throw. Around the eccentric sheave is fitted a band or strap, as it is termed, made in halves and bolted together, which strap is bolted to the heel of the eccentric rod. This rod is forked at its upper end and spans one end of the link. There are two eccentrics and all the necessary connections for each cylinder, one known as the 'go-ahead' and the other as the 'backing' eccentric. The go-ahead eccentric rod connects with one end of the link and the backing eccentric rod with the other end.

"Almost all links for large engines are of the double-bar type; that is, they are built up of two parallel steel bars, each forming the arc of a circle, the radius of which is equal to the

distance between the center of the eccentric sheave and the center line of the bars.

"You will notice the mechanism in the center of the link. That is known as the link block, and it forms the connection between the link and the valve stem. In operation the links are thrown from one side to the other, so that the link block is actuated by either the go-ahead eccentric or the backing eccentric, as may be desired, by placing the link block in line with either of these eccentric rods.

"Eccentric sheaves are always made of cast iron, in two unequal halves, in order to bring the joint between them on the center line of the shaft, so that they can be readily removed.

"The eccentric straps which ride on the sheaves are also made in halves, bolted together, and are usually of cast iron or cast steel, lined with white metal in order to reduce the friction.

"Eccentric rods and link bars are usually made of wrought steel of the best quality. The link blocks are usually of forged steel, fitted with composition wearing pieces where they rub on the link bars. Sometimes they are cast entirely of bronze.

"To reverse an engine, that is, to change it from the ahead motion to the backing motion, or *vice versa*, there is provided a rock shaft, which extends along the engine columns, and to

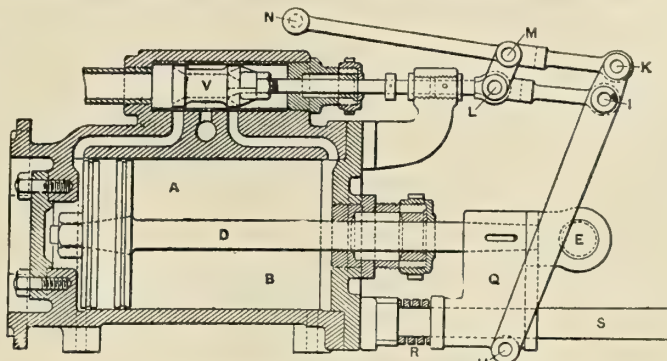


FIG. 17.—FLOATING LEVER REVERSE GEAR

which it is supported in brackets. On this rock shaft there is secured for the valve gear of each cylinder a lever, or reversing arm, as it is called. This arm connects to the valve gear links by suspension or bridle rods, as they are sometimes called. This rock shaft on small engines is operated by hand through the medium of a long lever, or in some cases by a large hand-wheel and screw. However, this means is not practicable for larger engines, as it would require more power than a man could apply. Hence all large marine engines are fitted with what is known as a reversing engine, which consists of a steam cylinder, the piston rod of which is connected by means of links to the reverse arm on the rock shaft. Fig. 17 will show you details of an ordinary reversing engine.

"The valve of this steam cylinder is controlled by what is termed a 'floating lever,' the initial motion being given it by means of the hand reversing lever located at the working platform. A small slide valve of either the flat slide or the piston slide type controls the admission of the steam to the cylinder. Unless the lever at the working platform is handled by an experienced man, the piston is liable to go forward or backward with a rush, causing the gear to slam. To avoid any damage being done it is customary to fit strong spiral springs at each end of the crosshead guide rod to prevent slamming."

(To be continued.)

NEW ENGINEER-IN-CHIEF OF THE UNITED STATES NAVY.—Rear Admiral Robert S. Griffin, U. S. N., has been appointed chief of the Bureau of Steam Engineering, succeeding Rear Admiral H. I. Cone.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Diagram of Formula for Vertical C. B.

Any reliable approximate formula is welcomed when checking completed calculations or when approximate results are wanted in the preliminary stages of a design. Graphical representation of a formula offers the additional advantages of being able to read the answer directly on a scale and of avoiding much arithmetical work. Also the effect upon the final result, due to a small change in any of the factors entering into a formula, is immediately *seen* in a diagram.

A case in point is Normand's approximate formula for vertical position of center of buoyancy. In its original form this formula gave the C. B. below L. W. L. in terms of draft.

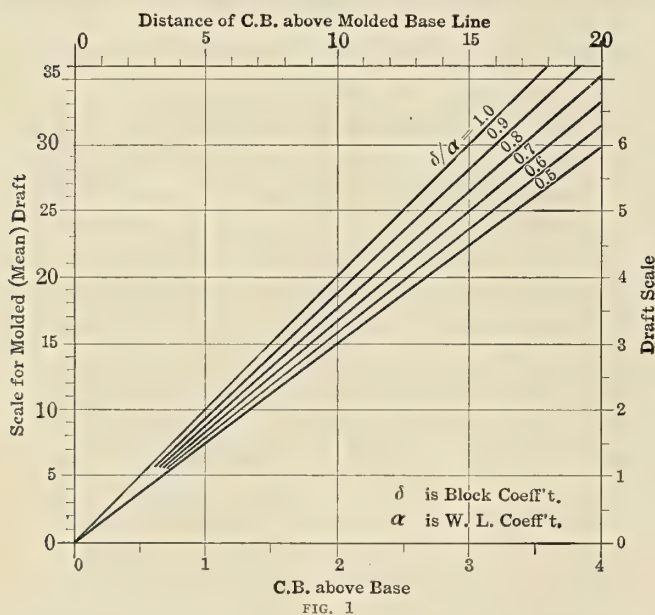


FIG. 1

displacement (volume) and area of water plane. In Simpson's "Naval Constructor," page 45, convenient substitutions have been made, the formula being transformed to read:

$$C. B. \text{ above molded base line} = d \left(\frac{5\alpha - 2\delta}{6\alpha} \right) \text{ where } d =$$

mean draft, molded.

α = coefficient of water plane.

δ = block coefficient.

Fig. 1 is a graphical representation of the above formula. The left-hand vertical draft scale extending to 36 units is used in association with the top horizontal scale to 20 units of C. B. above base. Using only the large figures of each scale (*i. e.*, up to 3.6 units vertically and 2 units horizontally) a virtual enlargement is obtained of the extreme lower left hand corner of the diagram. A similar virtual enlargement is obtained by using the right hand vertical draft scale in conjunction with the bottom horizontal scale.

Each of the radial lines in the diagram corresponds to a particular value of δ divided by α . Intermediate values of this ratio can be located by interpolation in a *horizontal* direction, since the intervals on a horizontal line between successive radial lines are equal.

Example: Find the vertical position of C. B. for a vessel 8,730 tons displacement at 21 feet draft (above top of keel). The area of 21 feet water plane is 15,900 square feet, length 383 feet by 50 feet breadth.

$$\text{Then } \delta = \frac{8,730 \times 35}{383 \times 50 \times 21},$$

$$\text{and } \alpha = \frac{15,900}{383 \times 50}.$$

$$\text{Whence } \frac{\delta}{\alpha} = \frac{8,730 \times 35}{383 \times 50 \times 21} \times \frac{383 \times 50}{15,900} = \frac{5 \times 8,730}{3 \times 15,900} = 0.91 +$$

Opposite the 21-foot draft mark (left-hand vertical scale) locate the value of the δ/α ratio ($= 0.91 +$) between the radial lines 0.9 and 1; then project this point up to the top horizontal scale and read off the distance of C. B. above base = 11.1 feet, which probably contains less than 1 percent error.

WILLIAM S. OWEN, B. Sc.

Cramp's Shipyard, Philadelphia.

Calculations for Strength of Propeller Blades and Studs

The following methods of calculating the bending stress at the root of propeller blades and the tensile stress on the studs securing the blades to the hub have been demonstrated to be thoroughly reliable in practice, and will be of service to draftsmen or engineers engaged in designing propellers.

Let S = the bending stress in pounds per square inch on the root section of a propeller blade.

I = the total indicated thrust in pounds.

$$33,000 \times I. H. P.$$

$$= \frac{\text{pitch of screw} \times \text{revs. per min.}}{n \times p \times b \times d^2}$$

a = the flat area of one blade.

p = the projected area of one blade.

n = the number of blades in *all screws*.

m = the distance in inches from the root section of the blade to the center of effort of the blade (see sketch).

b = the breadth of blade at the root section in inches (see sketch).

d = the thickness of blade at the root section in inches (see sketch).

$$I \times a \times 12 m$$

$$\text{Then } S = \frac{I \times a \times 12 m}{n \times p \times b \times d^2}$$

Comparing a number of cast iron blades by this formula showed that in actual practice S ranged from 1,600 to 2,700 pounds.

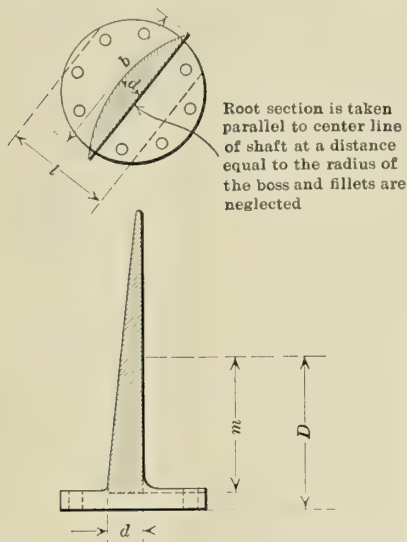
In calculating the stress on the studs, it is advisable to add to the tensile stress produced by the thrust on the blade the tensile stress produced by the centrifugal force of the blade. This latter force was not dealt with in considering the root section, because its effect on the root section is comparatively

trivial, owing to the large area of the section, but the total net section of the studs is small compared to the root section and the stress produced by centrifugal force is quite appreciable.

All the symbols above apply to the following formula, and in addition:

Let T = the mean tensile stress in pounds per square inch on the studs.

D = the distance from the face of the hub to the center of effort of the blade in inches (see sketch).



SKETCH OF BLADE, SHOWING SYMBOLS FOR FORMULA

C = the tension area of all studs on aft side of one blade in square inches.

l = the average length in inches of the arm at which the studs on the aft side of the blade act to resist the overturning action of the thrust on the blade (see sketch).

W = the weight of one blade in pounds.

R = the radius of the center of gravity of the mass of blade in feet.

N = the number of revolutions of the propeller per minute.

Y = the tension area of all studs in one blade in square inches.

$$\text{Then } T = \frac{I \times a \times D}{n \times p \times c \times l} + \frac{W \times R \times N^2 \times .0003427}{Y}$$

From a number of actual propellers it was found that T , the mean stress on the studs, was about 2,000 pounds per square inch and the maximum stress on any one stud was about one-third greater than the mean stress.

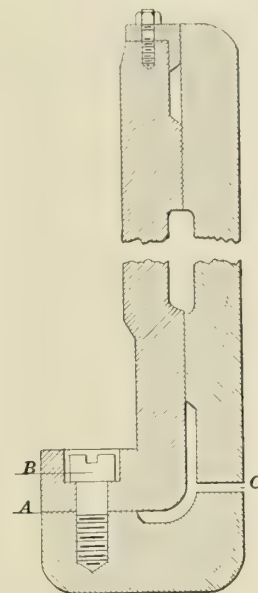
Toronto, Can.

R. M. FOTHERINGHAM.

A Leaky Joint on a Cylinder Liner Made Tight

Our low-pressure liner leaked so badly at the bottom where the flange made up on the cylinder at A that the hand on the jacket gage oscillated from the pin to the full pressure allowed on the jacket at every stroke of the piston. The lower man-hole plate on the cylinder had been removed, and the bolts, B , holding the flange inside the cylinder had been set up as tight as possible, but in spite of all that we could do we could not make the joint tight. This continued to be very trying for several weeks, for every time that we arrived in port some one was obliged to remain aboard and try to make the liner tight, and each time something else was tried. At last the lagging was removed at the bottom of the cylinder and a hole drilled and tapped to take a $\frac{1}{4}$ -inch pipe 3 inches

above joint at C . The cylinder was warmed to about 200 degrees, so that thinly mixed red lead would run nicely, and enough was forced through the hole between the liner and the cylinder so as to be about 1 inch deep at the bottom, then air pressure was applied until the lead was forced through the joint when the pressure was reduced to 5 pounds and allowed to stand for ten hours until the lead became quite thick, then the pressure was increased to 40 and allowed to stand until the lead became hard, the cylinder being kept fairly warm by



METHOD OF TIGHTENING JOINT BETWEEN CYLINDER AND LINER

letting just enough steam through the bypass valve to keep it at the required temperature. Then the pressure was removed, the lead cleaned off that had been forced through the joint on the inside, the hole plugged, the lagging replaced, and the liner has been perfectly tight ever since.

READER.

Counterbore and Packing Ring

The steamship *R*— was loading at New York for a voyage of 4,000 miles to the southward. Included in the overhauling was the fitting of a new ring in the high-pressure cylinder.

This cylinder was 33 inches in diameter, of 54-inch stroke and fitted with a liner. The piston was of the ordinary marine type, being made tight by a single snap ring $1\frac{1}{4}$ -inch square fitted in a groove in the center of the bull ring. In boring the liner a mistake had evidently been made, for the counterbore extended $1\frac{1}{2}$ inches above the flange of the piston when the engine was on the bottom center.

In trying the ring it was placed on the flange of the piston and the first assistant engineer ordered the engines jacked around while he watched the ring to see if it was clear in the cylinder. As it neared the bottom of the stroke he saw it spring out on one side, and immediately ordered the jacking engine stopped.

The oiler who was running the jacking engine, misunderstanding the order, reversed the engine. One sharp report and one-third of the piston flange dropped off. As it was less than twenty-four hours to sailing time, and as a spare piston was not on hand, it was necessary to repair the broken one, which was accomplished as follows:

The follower was clamped on the bull ring in its relative position on the platen of a drill press, and between the follower bolt holes, there being 12, was drilled a $\frac{7}{8}$ -inch tapping hole into the bull ring. These holes were tapped $\frac{7}{8}$ inch and Norway iron studs made to screw into the same long enough to pass through the follower and allow for heading

up. The holes in the follower were then reamed to pass over the studs and given a good countersink. The follower was again clamped on the bull ring and the studs riveted up tight, making the bull ring and follower one.

Meantime the bottom die on the cylinder had been removed, all broken pieces taken out of the cylinder and the die replaced. The snap ring was placed in its groove and the piston bolted together. As the follower was a good fit in the cylinder the stress on the studs was practically nothing.

The ship sailed on time and made the voyage of 4,000 miles without the cylinder giving trouble. On returning to New York a new piston having a solid floating bull ring, was fitted which could not get into the counterbore.

ENGINEER.

An Improved Device

The trap of our evaporator had its side and bottom corroded so badly that it was beyond repair, and not being able to get another one at the time, the drain was connected from the coil to the feed tank direct, and was regulated with a valve; but this was, of course, all guesswork; and the evaporator being situated in the shaft alley, it took a special trip to have a look at it, and the coil was either empty and blowing live steam into the feed tanks or filled with condensed water and not evaporating anything, where with a good trap one could get so used to regulating it that it was very little trouble. This was necessary, as the oiler had to attend to running the evaporator as well as attending to his other duties, but under the above condition it had become more troublesome than the main engine. One of the oilers devised a scheme that worked so well that we never replaced the trap.

A piece of 4-inch pipe with a cap on the bottom and a flange and stuffing box on top, that had once belonged to a pump governor, was made up and the stuffing box was made to fit a

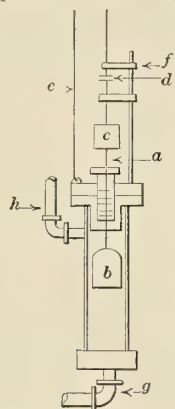


DIAGRAM OF DEVICE

$\frac{1}{8}$ -inch rod, *a*, with a float on the lower end, *b*, and extended up through a guide that was screwed into the top head and carried a small weight, *c*, just heavy enough to force the rod down when the water in the 4-inch pipe was low enough not to come in contact with the float, but when the water in the evaporator coil raised higher than it should the float would raise the rod and make a contact at *d*, and this wire, with wire, *e*, was run over to the throttle and connected up to the ship's wiring and a buzzer so that the man at the throttle would know when the coil needed blowing, and he could tell by the sound of the steam going into the feed tank when it needed closing. A drain valve was installed near the throttle, so it was very little trouble for him. The wire at the place of contact was insulated at *f*. Pipe *g* had a connection with the coil drain and pipe *h* to the steam pipe on the evaporator side of the reducing valve, so that the same pressure was maintained on the coil and the electric apparatus. The pipes *g* and *h* were insulated by enlarging the bolt holes in a flange on each and inserting the bolts in a fiber tube turned to fit

the bolts and bolt holes and a fiber washer under the head and nut. This was done to prevent electrolysis on the shell and fittings of the evaporator. Of course this was not automatic, as a trap would have been, but it worked very nicely, and after a short time the man at the throttle became so proficient in regulating the drain that it was not necessary to touch it more than three or four times a watch, and it was always in repair, which can't always be said of traps.

OILER.

Propeller Shafts—How to Preserve and How to Protect Them

Engineers have tried various methods of preventing corrosion to the propeller shafts of steamers, as well as of reducing the friction in the stern tubes. Water, as is well known, is not a lubricant, and yet, strange to say, 70 percent of the steamers running depend on water for the lubrication of their stern bushes and propeller shafts. No engineer would lubricate his engine with sea water, and yet the most important bearing in the ship is usually lubricated with it.

If a suitable lubricant can be employed in the stern tube, it stands to reason that the friction would be greatly reduced. Careful experiments conducted by a prominent marine engine builder have clearly proved this. It has been ascertained that with a shaft having a brass liner running in a lignum vitæ bush and lubricated with sea water, the coefficient of friction is 0.094, whereas with a steel shaft running in white metal and lubricated with oil the coefficient of friction is 0.048.

Some engineers have tried tallow or solidified oil in the stern tubes, but these are not desirable for several reasons. Tallow sometimes contains mineral acids and usually also an appreciable percentage of free fatty acid; it has also a tendency to turn rancid and to generate still more fatty acid. These acids tend to corrode the shaft and to perpetuate the galvanic corrosion which is caused by sea water. Another objection to tallow and to all solid lubricants is that any particles of sand which enter the stern bush are kept up against the shaft and act like a file upon it.

Any oil used in a stern tube should be non-corrosive, not only free from mineral acid but free from fatty acid; it should also be a semi-solid or non-fluid oil, for a thin oil has a much greater tendency to work out of the stern tube and be lost. The difficulty is to find a non-corrosive oil which is really a good lubricant and yet free from fatty acid. Hydrocarbon oils, such as vaseline, are free from fatty acid, but they have not the "oiliness" or high lubricating power which is essential for a large bearing like the stern bush. The corrosion which takes place in the stern tube is usually the result of galvanic action, just the same as the corrosion between the two metals in the battery of an electric cell.

In selecting a lubricant for this purpose it is advisable to choose a non-corrosive lubricant with the peculiar power of adherence to metal surfaces, so that once on the tail shaft it would be practically impossible for water to wash it off; also one that has a very strong lathering power—that is, it should make when mixed with water a flat or velvety lather (not a frothy one) of a very rich nature. The shafts which have been lubricated with this class of oil for many years are not showing the least sign of corrosion or rust.

There are various methods of applying the oil to the tail shafts. Some engineers force it into the stern tubes and allow it to find its way out through the bush. Others simply feed the oil by gravitation, but sometimes both of these methods answer, although usually sooner or later they are found to work unsatisfactorily, for both of these methods are far from economical.

In a future article the author will deal with oil retaining and stern tube appliances.

"GO-AHEAD."

Marine Articles in the Engineering Press

A French Diesel Engine.—In this article the design, construction and operation of the Sulzer-Diesel marine engine, as built in France at the works of the Forges et Chantiers de la Méditerranée at Havre, are discussed. While the Sulzer-Diesel engine is well known, there are some features in connection with the French development which differ from the designs produced by the parent works in Switzerland. The article is amply illustrated with drawings, diagrams and photographs. 7 illustrations. 4,000 words.—*The Engineer*, May 2.

The German Battleships of the Kaiser Class.—The German battleship *Kaiser* has the following main particulars: The length is 564 feet; breadth, 95 feet 3 inches; normal displacement, 24,119 tons; speed, 21 knots; main armament, ten 12-inch guns; secondary armament, twelve 5.9-inch and twelve 3.4-inch guns and five torpedo tubes. Sixteen watertube boilers of the Schulz type supply steam to impulse turbines of the A. E. G. type, distributed among three shafts and designed to develop 25,000 horsepower. The normal coal supply is 1,000 tons, the total coal and oil bunker capacity being 3,600 tons. The main armor belt is 12¾ inches thick, reduced to 6 inches and 5 inches at the ends; the turret armor is 12 inches thick. 1 illustration. 1,000 words.—*The Engineer*, April 18.

Motor Ship Suecia.—By J. Rendell Wilson. Burmeister & Wain, Copenhagen, recently built for the Rederiktiebolaget Nordsjæernan the motor ship *Suecia*, 362 feet long overall, 360 feet long between perpendiculars, 51 feet 3 inches beam, 25 feet 6 inches molded depth, 23 feet 1 inch draft, 6,520 tons deadweight capacity, 2,300 indicated horsepower, 10¾ knots speed. She is a twin-screw vessel with eight-cylinder engines, having cylinders 16½ inches diameter by 19.8 inches stroke, operating at 140 revolutions per minute on the four-stroke principle. The auxiliary machinery includes two 200 brake-horsepower four-cylinder non-reversible Diesel four-stroke engines, driving dynamos and air compressors. 2 illustrations. 750 words.—*Marine Review*, May.

Geared Turbine Steamers for the South Indian Railway.—Three geared turbine steamers, the *Curzon*, *Hardinge* and *Elgin*, have been built by A. & J. Inglis, Ltd., of Pointhouse, Glasgow, for the South Indian Railway Company. The vessels are 260 feet long overall, 38 feet beam, 18 feet 9 inches depth to promenade deck, with a gross tonnage of about 700. The propelling machinery consists of two sets of geared Parsons turbines driving twin screws. To each shaft a high-pressure and a low-pressure turbine are coupled by means of machine-cut gearing, which enables the turbines to be run at 3,500 revolutions per minute, while insuring an efficient low speed for the propellers. A high-powered astern turbine is embodied in each low-pressure casing. Two Yarrow watertube boilers, specially designed for burning inferior qualities of coal, supply steam. The vessels are provided with bow and stern rudders, controlled by steam-steering gear. 6 illustrations. 350 words.—*The Engineer*, May 2.

Destroyer Developments.—The name torpedo boat destroyer no longer describes the functions of the vessels designated under this class; for their efficiency as war units must be judged not in relation to torpedo boats, but by their value for delivering torpedo attacks on battleships and battle cruisers under war conditions and on the high seas. It is held inevitable, considering the advance in speed of the larger units and the increasing effectiveness of the submarine, that what has hitherto been called the destroyer class should move to a somewhat more important position. It is suggested that if the destroyers were increased to a length of from 300 feet to

320 feet, with a speed of 36 knots, they would be effective both as torpedo vessels and as dispatch cruisers or scouts, thus creating a class of torpedo scouts which would become a real menace to hostile battleships or cruisers. Recent developments of propelling machinery, so that the necessary power for such vessels can be produced on comparatively small weight, makes the creation of such a class of war vessels seem desirable. 1,350 words.—*The Engineer*, March 14.

The Shelter Deck Cargo Steamers Bridgeport and Glacebay.—The steamers *Bridgeport* and *Glacebay*, built by Messrs. William Doxford & Sons, Ltd., of Sunderland, for London owners, constitutes a type of ship particularly suitable for the carriage of heavy bulk cargoes, such as coal and ore. A leading feature is that wing ballast tanks have been provided on each side for nearly the full length of the shelter 'tween decks. The vessels are 458 feet long overall, 442 feet 9 inches long between perpendiculars, 58 feet extreme breadth, 28 feet 9 inches molded depth to upper deck, 35 feet 9 inches molded depth to shelter deck, 25 feet load draft, 11,000 tons load deadweight, 710 tons bunker capacity. The five cargo holds in the vessels are each provided with a hatchway 35 feet wide by more than 40 feet long. Deep frames of channel section, spaced 37 inches apart for the greater part of the length, support the side plating. The propelling machinery in each vessel consists of one set of triple-expansion engines, having cylinders 28½, 47 and 78 inches diameter by 54 inches stroke, driving a single screw. The boilers are of the ordinary cylindrical multi-tubular type. 2 illustrations. 600 words.—*The Shipbuilder*, May.

Some Further Notes on Approximate Stability.—By Arthur R. Liddell. The method of constructing a curve of levers for the longitudinal stability of a ship is given, and this subject leads to the discussion of the safety of a vessel against foundering. It is pointed out that the safety would be greater than it usually is if vessels were made broader and deeper on given lengths and drafts than at present. The reasons why they are not so designed are: (1) That their tonnage would be greater and their dues heavier; (2) that thickness is now apportioned by the size of the vessel and not enough by the stresses which they have to withstand. The dues might very well be assessed upon some other basis that would not hamper design. If the tonnage system cannot be given up, deductions might be allowed: (a) For excess of surplus buoyancy over the standard; (b) for excess of length of the fore and after peaks over the amounts of 5 percent of the length forward and perhaps a little less aft now ruling, since both these surpluses make for increased safety. The greatest longitudinal stresses in a vessel occur about mid-length, and to relieve this part as much as possible the centers of gravity of the fore and after bodies respectively must be above or nearly above their centers of buoyancy. The part of the total stress due to weight distribution is thereby minimized. The part due to wave action, which is greatest in degree in the smallest and least in degree in the largest vessels, cannot be avoided. The third source of longitudinal stress—that due to water pressure—must be kept down as much as possible by suitable design of the framing. 2 illustrations. 2,600 words.—*The Engineer*, April 25.

Weight and Freight of Merchant Ships.—An editorial discussion of the paper read before the Liverpool Engineering Society by T. C. Tobin, M. A., dealing with the question of how does the margin of freight-carrying displacement vary per ton of structural material for vessels of differing dimensions? The standard vessel adopted for comparisons in this paper is Class 100 A-1 at Lloyds, and is of the shelter-deck

type. Calculations of weight were made for ships of the following dimensions: 300 feet by 40 feet by 24 feet to shelter deck, two decks; 400 feet by 50 feet by 32 feet to shelter deck, three decks; 500 feet by 60 feet by 40 feet to shelter deck, four decks; 600 feet by 70 feet by 48 feet to shelter deck, four decks. These calculations were made for two degrees of fullness, .80 and .65 block coefficient as representing normally the full-lined tramp and the intermediate liner type of vessel. In addition to these calculations others were made of a deep type ship by adding 8 feet to the depth, and also for a wide type by adding widths to the standard beam adopted, varying proportionately from 10 feet on the 600-foot ship to 5 feet on the 300-foot ship. The most striking conclusion from the author's figures is the marked advantage which the large ship possesses over the small one. Vessels above 400 feet long carry equal deadweight per ton of structural weights, although the speeds at which they are assumed to carry it are proportioned to the square roots of their lengths. In other words, as is generally known, the big ship is the economical one. The wide type seems to be only slightly more economical in the bigger ships, but there is a distinct gain by transition to the deep type, so that the most economical freight carrier is the large, full, deep, narrow type. 1,200 words.—*The Engineer*, March 7.

Spanish Transatlantic Liner Infanta Isabel de Borbon.—The steamship *Infanta Isabel de Borbon* is a sister ship of the *Reina Victoria Eugenia*, recently described in the engineering press, differing from the latter, however, in having three instead of four propellers. Two reciprocating engines drive the wing screws and an exhaust turbine the center shaft, whereas in the ship previously described, which had four screws, the inner shafts were driven by reciprocating engines and the outer shafts by exhaust turbines. The *Infanta Isabel de Borbon* was built by Messrs. Denny of Dumbarton for the Spanish Trasatlantica Company, a company which was formed fifty-seven years ago, and has been an important factor in the commercial progress of Spain. The history of the development of this company, and the type of vessels which have been in its service, are described in an interesting manner in this article. This company, of course, benefits by the act which was passed by the Spanish Government in 1909, known as the "Protection of the Mercantile Navy Act." Under this act the Compañía Trasatlantica was awarded the contract for mail service to practically all the important ports in the world associated with Spanish history and trade. In addition, the act provides for subsidies for shipbuilders graded not only according to the size of the ship but also according to the horsepower and speed. The principal dimensions of the *Infanta Isabel de Borbon* are: Length between perpendiculars, 480 feet; breadth, molded, 61 feet; depth, molded, 35 feet 9 inches. She is of the shade-deck type, with six steel decks, the hull being divided into watertight compartments by nine transverse bulkheads. Accommodations are provided for 250 de luxe, 100 first class, 80 second class and for 1,600 emigrants, while a crew of some 250 are also carried. This article describes the passenger accommodations and certain of the auxiliary machinery installations, such as the ventilating, refrigerating, electric and cargo-handling equipment. 8 illustrations. 4,300 words.—*Engineering*, May 2.

The Story of the Cunard Line.—Tracing the development of the famous Cunard Line from its inception in 1840 to its present premier position unfolds a fascinating tale of energy and vitality. The history of the line is, of course, well set forth by comparison of the various vessels which have been built for its service year after year. Starting with the pioneer steamship *Britannia*, which was a wooden paddle-wheel boat, 207 feet by 34 feet 4 inches, of 1,154 tons, built in 1840, a description is given of the various Cunard steamships up to the latest monster *Aquitania*,

which is now being built. Aside from the details of the company's vessels, the article shows how the Cunard Line has recently become affiliated with other important steamship lines, such as the Anchor and the Thompson Lines. In conclusion, two points are emphasized in regard to the Cunard Line; first, the wonderful measure of safety with which its services have been conducted, for it still may be truly said that there has never been the loss of a Cunard mail steamer by which the life of a passenger has been sacrificed. The other point is its intense vitality. 15 illustrations, 2,800 words.—*Marine Engineer and Naval Architect*, May.

Progress in Motor Shipping.—An impartial view of the present state of development in the construction of large motor ships and the prospects for the future cannot be taken without weighing carefully many factors which enter into the question. The factor of most importance is the supply of fuel oil and its price. In purchasing fuel for ships, whether it is coal or oil, it should be remembered that a ship's supply of fuel cannot all be purchased at one point, but that the ship must buy her fuel at various ports where the price varies; so in order to strike a true comparison between the cost of operating a motor ship and a steamship the price of coal at various ports must be taken into consideration. Allowing the usual four-to-one ratio in comparing motor and steamships, it will be found that oil only ceases to be less economical than coal when it reaches the price of about \$24 (£5) per ton, which is, the company's vessels, the article shows how the Cunard however, much higher than it stands at present. 1,800 words.—*The Motor Ship and Motor Boat*, April 24.

A Theory of Surface Condensation.—By D. B. Morison. The Contraflo kinetic condenser was evolved after patient and prolonged research, resulting in the ultimate adoption of the multiple-wedge chambers arranged in parallel within a shell, the flow through the wedges being continuous and the proportions of the wedges such as to reduce steam turbulence at entry, facilitate gradual air collection during flow, and promote air concentration at exit. The crucial problem in the attainment of high vacuum is how best to treat the small quantity of air which normally enters the condenser with the steam, and make at the same time provision for dealing with the much larger quantities which result from accidental and inevitable leakage into the system. The weight of air which always remains in a condenser must be reduced to a minimum, and must offer the least possible resistance to the transmission of heat to the circulating water. Furthermore, each air particle should take its shortest route from the exhaust inlet to the air outlet, and not linger on the way. Such a theory at once suggests that exhaust steam should enter a condenser as a uniformly moving column, the sectional area of the column being the plan area of the top row of tubes. The nearest practical approach to this requirement is a wedge section having a very narrow outlet. By means of the wedge the air is disposed in pressure gradations which reach a maximum at the outlet from the condensing chamber. It is, moreover, highly essential that the disposition of the gradations at the outlet shall be such that a given weight of air presents as small a surface area and as great a depth as the practical requirements of sufficiency of passage permit. Concurrently, the air pump is enabled to maintain such an air condition within the condenser that the air pressure at the air outlet is minimized, the air insulation within the condenser is reduced, and the greatest amount of heat is transmitted to the condensing water. Another phenomenon which must be utilized for promoting a higher efficiency of air pump is the kinetic energy of the inflowing steam. To do so it is necessary to deflect the current towards the air outlet, with the result that there is less air insulation in the condenser. 8 illustrations. 3,250 words.—*Journal of the American Society of Naval Engineers*, February.

New Books for the Marine Engineer's Library

Propellers

REVIEWED BY PROFESSOR W. F. DURAND*

PROPELLERS. By Professor C. H. Peabody. Size, 5¾ by 9 inches. Pages, 132. Illustrations, 29. New York, 1912: John Wiley & Sons. Price, \$1.25 net.

This book is intended as a practical abstract of the author's more extended treatment of the same general subject in his work *Naval Architecture*, and to which reference is made for the details of experimental work cited and for theoretical discussion. The purpose of the present volume is to present in a reliable and convenient manner a method of designing propellers based on model experiments and free from the intricacies of refined theoretical discussion.

All practical methods for ship or propeller design are based ultimately on the law of comparison or of kinematic similitude, and while the theoretical discussion of this law in detail presents many points of abstruse theory, the general conclusions and resulting methods may be stated briefly and readily applied.

The author has developed in detail a method for the design of the form of propellers based on the ellipse as the standard form of projected contour, and adapting the experimental results derived in the United States Experimental Model Basin in Washington to propellers of this form of projected contour, but with varying structural proportions, has derived a series of coefficients covering propellers of two, three and four blades, a range of values of the pitch ratio from .60 to 2.00, a range of values of the slip ratio from .06 to .34, and certain values of area ratio and of blade thickness ratio covering the range of usual practice in these respects.

By the aid of these coefficients introduced into the fundamental equations, the characteristics of a propeller to meet within limits any proposed schedule of operation may readily be determined. Several illustrative examples are worked through, and in addition to the propeller tables there are added tables giving various quantities likely to be of use in estimating power and speed.

The book should be of special interest to marine designers and engineers primarily concerned with the consideration of numerical and practical problems.

Miscellaneous

THE STOKER'S GUIDE TO PROMOTION. Size, 5 by 7¼ inches. Pages, 179. Numerous illustrations. London, 1913: The Fleet, Ltd., 11 Henrietta street, Covent Garden, W. C. Price, 3s. 6d. net.

This book is useful particularly to firemen in the British navy, as it was intended to deal exclusively with the various examinations the naval stoker has to pass for higher rating. Although designed primarily to meet the needs of a certain class of men the book contains information which would be found very useful to a young man trying to work his way up from the stokehold to the position of an engineer in the mercantile marine. The first two chapters contain a concise and straightforward explanation and guide to arithmetic and mensuration. The next chapter takes up boiler questions, and as it is rather brief, considering the subject treated, it is evidently assumed that the stoker is very familiar with the boiler side of the question. The next chapter, and by far the most important in the book, is entitled "Engine Questions,"

and by giving almost every conceivable question that would be asked in an examination, together with the answers, illustrated in many cases by sketches, the student can gain a very comprehensive knowledge of the various details in a steamship engine room. It is pointed out in the foreword that any one having a good knowledge of the contents of the book is almost certain to pass examinations for promotion from the stokehold.

JOHNSON'S FIRST AID MANUAL. Fifth edition. Edited by Fred. B. Kilmer. Size, 5¾ by 8¼ inches. Pages, 143. Numerous illustrations. New Brunswick, N. J. 1912: Johnson & Johnson. Price, 50 cents.

Accidents are by no means infrequent even in the best regulated shipyards, and it is of great advantage to have at least one man in the yard, if not more, who has some knowledge of how to give prompt aid to the injured. The book in review is a first-aid manual for everyday use, and almost everyone who can read or understand a picture can gain information from it which will be of great service in caring for injured persons in an emergency. The book would be a handy thing to have around a shipyard and serious trouble might be avoided if some of the men in the shop were familiar with its contents.

Engineering Writing

HANDBOOK OF ENGLISH FOR ENGINEERS. By Professor Wilbur Owen Sypherd. Size, 4½ inches by 6¾ inches. Pages, 314. Chicago and New York, 1913: Scott, Foresman & Company. Price, \$1.50.

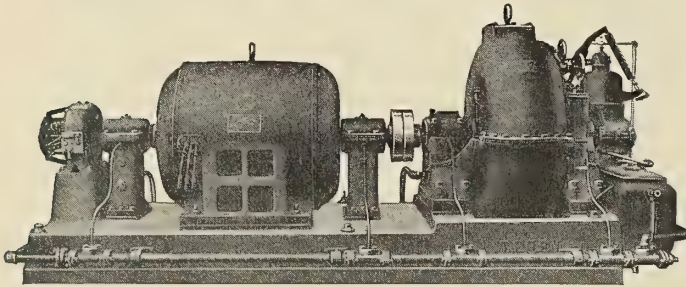
This book is designed primarily, as stated in the preface, to meet the needs of advanced engineering students and of young engineers in actual practice. In the preparation of the book the author has also kept in mind its usefulness to engineers already actively engaged in the practice of their profession. The scope of the book can be seen from the chapter headings, which are: Chapter I., The General Problems of Engineering Writing; Chapter II., Mechanical Details Common to the Various Forms of Engineering Writing; Chapter III., Business Letters; Chapter IV., Reports, and Chapter V., Articles for Technical Journals. The nature of the material in the book is such that the specimens of different forms of writing will not only serve as useful models for the inexperienced man, but they are also suggestive in a general way and will lead the reader to a true appreciation of the underlying principles established by custom and expediency which should govern all good engineering writing. The models of letters, reports and articles for technical journals illustrate the forms generally approved for such compositions, and should furnish useful suggestions for most of the writing required from engineers. The mechanical details common to the various forms of technical writing involve certain rules regarding punctuation, abbreviations, numbers, capitals, etc., which should be familiar to engineers in order to avoid confusion in important written documents. While the ability to speak and write English correctly and convincingly on almost any subject depends largely upon clear thinking and a thorough knowledge of the subject under discussion, yet the failure to master the ordinary technique of engineering writing imposes a serious and needless handicap upon an engineer, even if he is a man of exceptional technical ability. For overcoming such a handicap the book under review will be found in many ways a valuable aid.

* Professor of Mechanical Engineering, Leland Stanford University, Cal.

ENGINEERING SPECIALTIES

The Latest Type of Terry Turbo-Alternator

The Terry Steam Turbine Company, Hartford, Conn., who build turbo-generator sets from 5 to 300 kilowatts, either direct or alternating current, have recently put on the market the Terry "Type C H S," 3,600 revolutions per minute, turbo-alternator. In this set the bearings are supported from the base and close together; thus there is no expansion and change in alinement. The construction is costly all the way



through, but such as the builders consider proper where high speed is used. The casing is hung from the center and is split horizontally, as is the case with all Terry turbines. This means that alinement, steam connections, bearings, etc., are not disturbed to open the casing, which can, consequently, safely be done by the user if necessary. The equipment includes an emergency governor and steam strainer. A rugged self-contained forced feed lubrication system is used.

Miniature Voltmeters and Ammeters

There are many occasions when voltmeters or ammeters are required which are light, of small size, and yet accurate, durable and reliable. These conditions were met in the production of a line of miniature voltmeters and ammeters recently put on the market by the Weston Electrical Instrument Company, of Newark, N. J.

The instruments are constructed on the permanent magnet movable coil principle, and the line includes voltmeters, am-

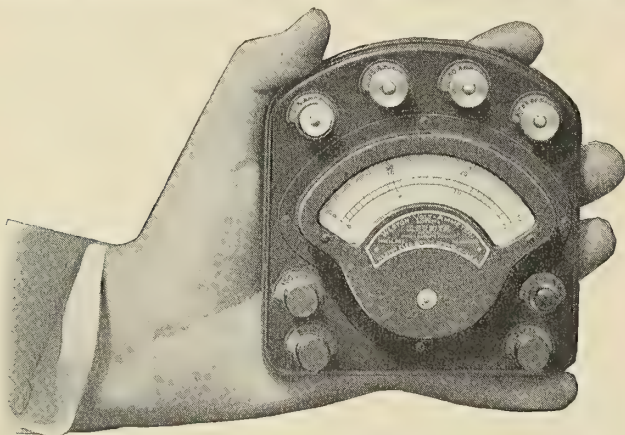


FIG. 1.—PORTABLE VOLT AMMETER

eters, volt-ammeters, special battery testing voltmeters and milli-ammeters. Single, double and triple range volt-ammeters are also offered in various combinations. The standard finish is dull black with nickel trimmings. The weight of these instruments is less than 1 pound each, and they are so compact that they may be easily carried in a coat pocket. The portable forms have knife-edge pointers, and the switchboard type has a pear-shaped or "spear-head" pointer, to permit its being read at a distance. The scale is 2.75 inches in length,

and the entire instrument in portable form has outside dimensions of only 4.4 by 4.6 inches. These instruments are practically unaffected by changes in temperature, and are shielded against magnetic fields.

Fig. 1 shows a triple range volt-ammeter, which is just one-half actual size. With this instrument any current from 30 amperes to 0.05 ampere may be determined, and any voltage from 150 volts to 0.02 volt may be directly measured. Fig. 2 is a miniature switchboard meter. The movements in these instruments are practically identical with those in the port-

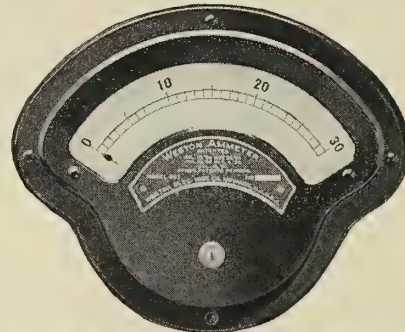


FIG. 2.—SWITCHBOARD VOLT AMMETER

able form. They are made only in single range with back connections.

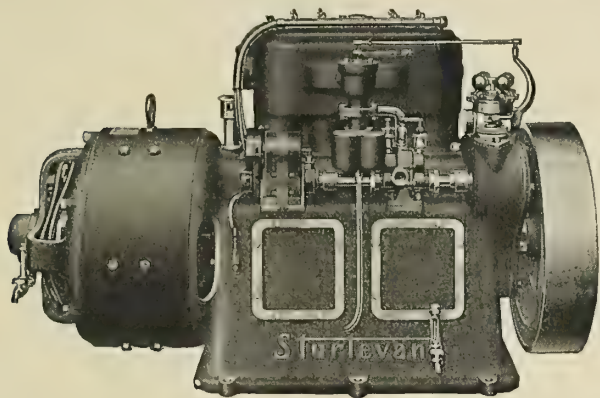
The company also manufactures a portable battery testing voltmeter, in which a steel point may be fastened to one terminal and a flexible cord with another point attached to the other terminal. These are furnished with the instrument and permit the rapid measurement of the individual cells of a battery. The scale is regularly calibrated with zero in center. On gasoline (petrol) launch switchboards and elsewhere, when space is an important consideration, and one instrument must be used for the determination of current and electromotive force, the company furnishes a special volt-ammeter. Normally, it indicates the charging or discharging current, but when pressure is applied to a contact button it registers volts without breaking the current circuit.

Sturtevant Gasoline (Petrol) Electric Generating Sets

The Sturtevant gasoline (petrol) generating sets, consisting of Sturtevant gasoline (petrol) engines, direct connected to Sturtevant direct-current electric generators, are built by the Sturtevant Manufacturing Company, Hyde Park, Mass., to supply the demand for electric generating sets that will be easy and inexpensive to operate. Gasoline (petrol) is a fuel that can be obtained anywhere, and gasoline (petrol) engines have been perfected so that they are reliable and require little attention, while they are cheaper to operate and more efficient than the steam engine. Furthermore, such a generating set can be easily operated by any one capable of taking care of an automobile or motor boat engine, and the services of an experienced engineer or of a person in constant attendance are not required.

Generating sets of this type are particularly useful for marine work, as they can be located on an upper deck in the ship, where they are unaffected by any accident in the engine or boiler room. The sets are built in three sizes of 5, 10 and 15 kilowatts capacity, capable of lighting 200, 400 or 600 20-candlepower tungsten lamps, respectively. A long-stroke engine has been designed as the most efficient and practical for this service, and both engine and generator are capable of operating under an overload of 25 percent for two hours. The engine is of the four-cycle water-cooled vertical type, with either four or six cylinders, according to the size of the unit. The generator is of the same type as has been used successfully in connection with Sturtevant steam engines for the United States navy and for the merchant marine.

The engines are fitted with an improved system of forced lubrication, while all moving parts are enclosed within an air-tight base, so that the sets are very clean in operation, are economical of lubricating oil and are easily taken care of. The speed of the engine is controlled by a specially designed vertical throttling governor of the centrifugal type, operated through bevel gears from the end of the cam shaft. It is claimed that the governor will control the speed of the engine to so close a degree of regulation between no load and



full load that voltage variations due to constant changes in load are imperceptible. The regulation is so close that no storage battery is necessary to maintain a constant voltage, when the generator is supplying current directly to the lighting or power circuit. Ignition is furnished by a high-tension Bosch magneto and no batteries are required for starting. These generating sets can be furnished for operation with gas or kerosene instead of gasoline (petrol) if preferred, and generators may be had for all voltages.

The sets are sold by the B. F. Sturtevant Company, Hyde Park, Mass.

The White Mechanical System of Burning Fuel Oil

The White mechanical fuel oil burner, manufactured by the Washington Engine Works, New York City, is a simple device, consisting of an arrangement (Fig. 1) for driving the oil along a cone so that its velocity will not be retarded and impinging it on a second cone with a finer angle, thereby causing it to be delivered from the burner orifice in a very fine spray, which can be ignited with the oil at a pressure of from 20 pounds up. The pressure generally used on the oil is from 60 to 80 pounds. The flame commences at the end of the burner, and it is claimed the fuel is completely consumed in the furnace itself, resulting in a freedom from smoke even when using the heaviest of oils. A special feature of the device is the manner in which the air admission is regulated, and also the manner of completely closing off the air supply when the burners are not in use, so that the danger of leaky tubes and seams in the combustion chamber is eliminated.

When applied to natural draft boilers the arrangement (Fig. 2) consists of an air-heating front, which is fitted over the mouth of the furnace and formed by a disk casting having a number of projecting vanes forming air passages. The air enters at the periphery of the disk, and passing down these passages absorbs heat from the vanes and disk, becoming heated to a high degree of temperature before coming in contact with the atomized fuel. The vanes in this furnace front conduct the air to the center of the disk, where it is admitted to the furnace, surrounding the burner, which is fitted with a perforated jacket and a sliding cone, which can be regulated to supply the required quantity of air. When applied to marine boilers fitted with the Howden system of forced draft, the doors are the only part removed from the furnace fronts, and

the White door, carrying the complete oil fuel burner installation, is fitted in its place. In this installation (Fig. 3) the air passages are cut in the side walls of the furnace casting, and the air is conducted to the center surrounding the burner.

In burning fuel oil by the mechanical spraying system, the oil is first heated to 150 degrees, and in some cases to 260 degrees F., according to the oil used. The oil heaters used in this system are of special design, and before the oil is delivered to the burner it is, of course, passed through filters or strainers, which are also of special design.

The advantages of this system are attributed in a large measure to the heating of the air supply, the control adjustment of the air supply, and the method of mixing the air and

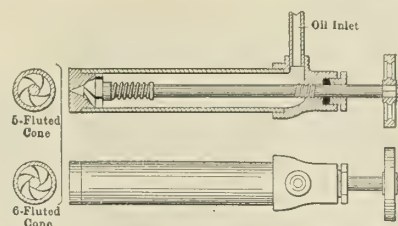


FIG. 1.—WHITE MECHANICAL OIL BURNER

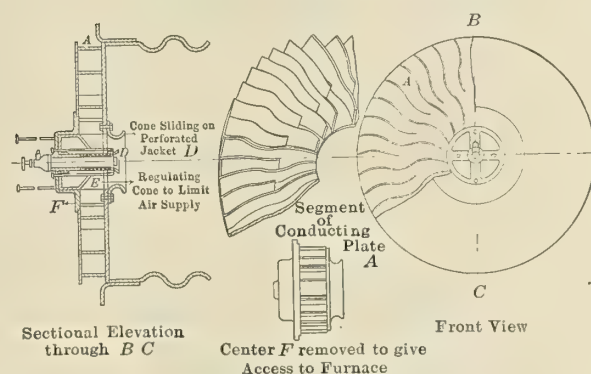


FIG. 2.—ARRANGEMENT FOR NATURAL DRAFT

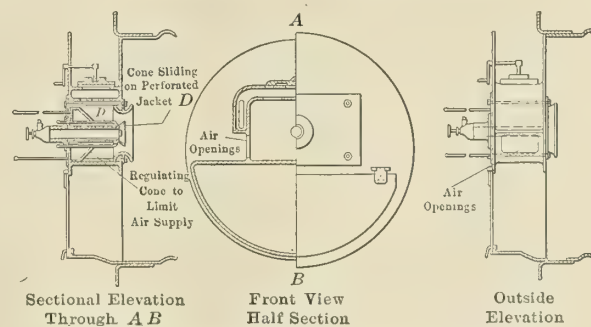


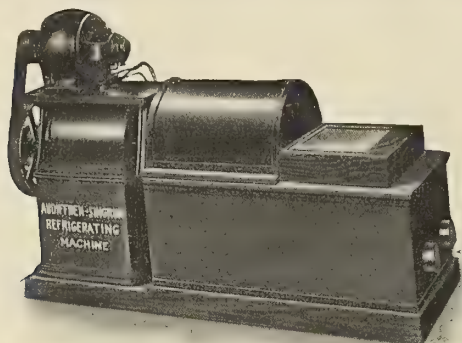
FIG. 3.—ARRANGEMENT FOR HOWDEN'S FORCED DRAFT

fuel, resulting in complete combustion in the furnace itself and the eliminating of smoke at the stack. No brick work is found necessary, and none is used, thereby tending to promote the circulation of the water in the boiler. The feature of using radiated heat from the furnace mouth to heat the air has a further advantage by giving a remarkably cool stokehold. Tests show a fuel consumption of only .93 pound per horsepower-hour.

Audiffren-Singrun Refrigerating Machine

The Audiffren-Singrun machine illustrated is a practical ice-making and refrigerating machine, designed to make from 11 to 110 pounds of ice per hour, according to its size, and it can be used for a combination of refrigeration and ice making. When used for refrigeration it connects readily with any type of ice-box. The machine operates on the compression system, using sulphur-dioxide as its refrigerating agent.

The machine is simple in construction, the principal parts consisting of simply a shaft carrying at one end a drum, on its middle another drum, and on its opposite end a pulley, gear or other means for revolving it. Its appearance is practically that of a large dumb-bell, and when it is in place the end drum is in contact with water, brine or other liquid to be cooled. The dumb-bell is sent out from the factory completely charged and ready to operate. The air is entirely exhausted, and the charge of sulphur dioxide and pure neutral oil is admitted, after which the machine is hermetically sealed. When



operating, the working parts are constantly lubricated, as pressure in the cylinder is constantly forcing oil between the working surfaces of the compressor.

Refrigerators cooled with the Audiffren-Singrun machine can be maintained constantly at a temperature of 35 to 40 degrees, which, together with an almost total absence of dampness, makes the refrigerator highly sanitary. Practically any one can run the machine, as for operation it is simply necessary to turn on the water and the power, which is usually supplied by an electric motor. There is nothing to get out of order, no connections to leak, and the pressure is not sufficiently high to cause an explosion in event of accident from any external cause.

This machine is a French invention which has been on the market for a number of years with satisfactory results. The H. W. Johns-Manville Company, New York, are the selling agents in the United States.

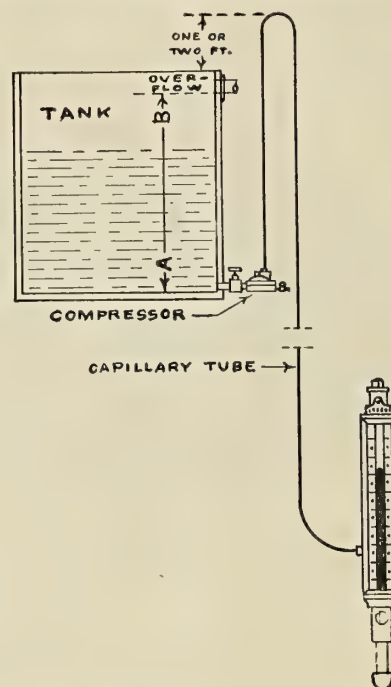
The Hydro-Cator

A new hydraulic indicator called the Hydro-Cator is manufactured by the Sterling Gauge Company, Detroit, Mich.. This instrument is used for indicating the depth of water or other liquids, and can be located any distance above, below or from the liquid to be indicated. It is adapted for tanks of all kinds, such as water, fuel oil, settling tanks and water compartments in floating dry docks and cranes, also ballast tanks, etc. The instrument itself is very simple, being free from any mechanism or moving parts, it shows at all times the exact amount of water in the tanks of compartments, in feet and inches or gallons.

The contents of the tank is shown by a brilliant red liquid or mercury in a glass tube, the scale reading is ten inches high for the standard instruments, which represents the full depth of tank, whether it is 2 feet or 100 feet, as each gage is specially calibrated for the depth of tank and the specific gravity of the liquid to be indicated. The manufacturers make them up with longer glasses up to 72-inch readings if desired.

The instrument is fastened to a wall or bulkhead, and a $\frac{1}{8}$ -inch outside diameter capillary copper tube, annealed and very flexible, is run to the tank. The tube contains only air and can never freeze or stop up. One end of this hollow wire is attached to the top of a casting 6 inches in diameter, which is called the compressor, and is attached to the bottom and

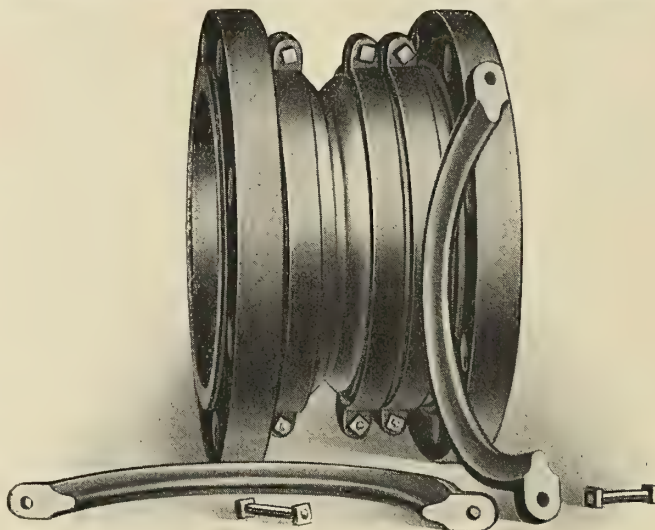
outside of the tank as shown, or may be simply lowered through the top to the bottom on the inside. The static pressure of the liquid in the tank forces the trapped air in the compressor and tube line against the indicating liquid in the instrument and causes it to rise in the glass tube in exact proportion to that in the tank. The apparatus can be installed



without emptying the tanks of their contents, and it is charged any time by attaching a standard bicycle tire pump to the cap on top of the instrument. One valuable feature is that the readings of the instrument are not changed or disturbed by any listing or racing of the boat in a heavy sea. The United States Navy are now specifying and have a large number in use.

The Badger Self-Equalizing Expansion Joint

The Badger self-equalizing expansion joint, made by E. P. Badger & Sons Company, Boston, Mass., is a corrugated



copper joint having external rings. It is designed to take up changes in length in pipe lines, whether these pipe lines convey steam, water or air. The well-known corrugated form, such as used for furnaces of internally-fired marine boilers, is adopted because of its strength and flexibility. External

rings on the corrugations, besides adding to the strength of the joint, distribute the strains among several corrugations, and by thus bringing many corrugations into service no one of them is called upon to take more than its share of the work. The number of corrugations depend upon the pressure and upon the length of the joint. For high-pressure and super-heated steam the change in length is considerable, therefore more corrugations are used. For very low pressures, as in exhaust piping, two or three corrugations are sufficient for the slight alteration in length.

The Francke Flexible Coupling

The Francke flexible coupling, shown in Fig. 1, which is sold by the Smith-Serrell Company, Inc., 90 West street, New York City, is simply an ordinary flanged coupling connected by flexible pins instead of rigid bolts, the faces of the flanges being slightly separated. The flexible pins, details of which are

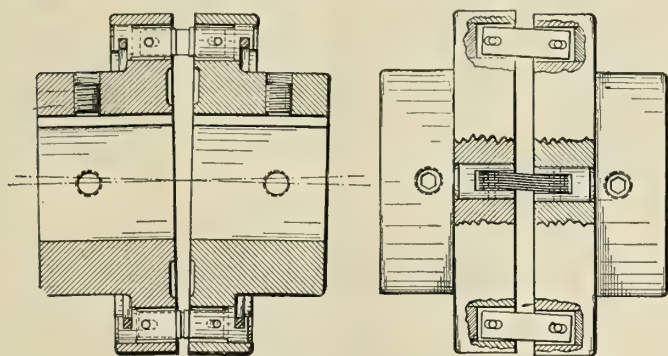


FIG. 1.—SECTIONAL VIEWS OF FRANCKE COUPLING

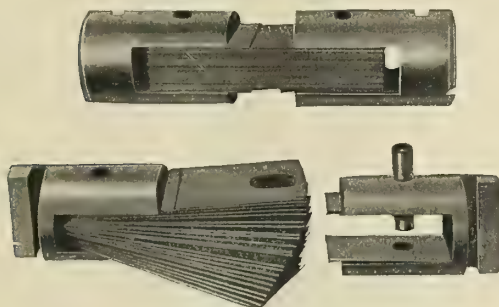


FIG. 2.—FLEXIBLE PIN

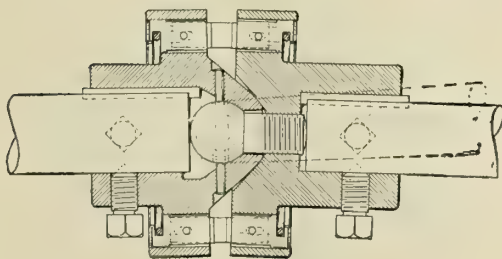


FIG. 3.—MOTOR BOAT COUPLING

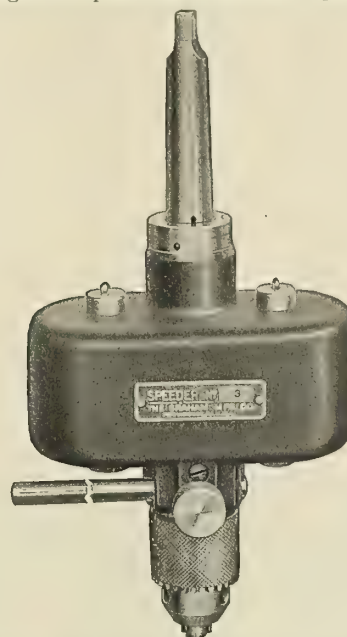
shown in Fig. 2, are built of laminated clock steel springs united at each end by a soft steel keeper. The long leaves with the elongated hole do the driving, while the short ones are simply used as shims between the driving leaves and the soft steel keepers. No strain comes on the hardened steel cross pins, which are pressed into the keepers to make the whole pin an easily handled unit. A snap ring holds the keeper stationary in the flanges, yet the long leaves are free to slide, rock or bend, and thus with a very slight movement between the hardened steel surfaces take care of any accidental misalignment.

The Francke flexible coupling has been used on auxiliaries,

such as pumps, fans, motors, dynamos, steam turbines, steam and gas engines, hoists, etc., in sizes up to 10-inch shafts. Larger sizes are in preparation to handle any size shaft in use, while it is intended in the near future to adapt the coupling to the shafts of ocean steamers, as, for instance, in the connection between a steam turbine and the pinions of the reduction gear. A special type, known as the motor boat or marine type (Fig. 3), is made which differs from the standard type, in that it will transmit the propeller thrust straight through the coupling to the main thrust bearings, which are usually a part of the engine, in sizes under 200 horsepower. This type of coupling is built for shafts from $\frac{3}{4}$ inch to 4 inches diameter.

New Drill Speeders

The Graham Manufacturing Company, Providence, R. I., has just brought out a new line of drill speeders, or high-speed drilling attachments, for use in drill presses of the larger class where small holes are to be made. The device increases the speed of the drill three times, and thus converts a slow-running drill press into one of high speed, thereby

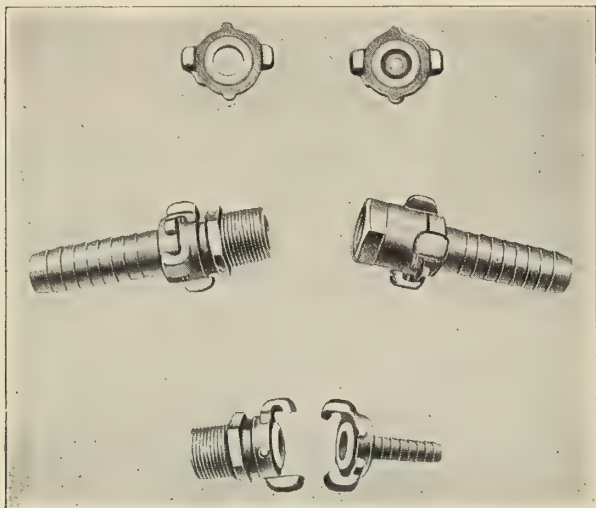


saving the cost as well as the space required for an extra high-speed machine. The general type is shown in the illustration. The shank is made in standard sizes to suit the holes in ordinary drill presses. On the bottom is fastened a regular drill chuck, which revolves three times to once of the spindle of the main machine. Instead of the chuck the spindle may be extended and made to accommodate taper shank drills. The driving mechanism that increases the speed consists of gears and pinions arranged in double, so that side strains are eliminated. No end thrust is conveyed through the case. A ball-bearing between the bottom of the slow-revolving shank and the top of the fast-running spindle relieves all end strain. The alinement, which is quite important, is accomplished by extending the lower end of the shank downward inside the hollow chuck spindle until it is nearly as low as the bottom of the case itself. The spindle is further supported by a bronze sleeve on its outside.

The Chicago Hose Coupler

The Chicago hose coupler, manufactured by the Chicago Pneumatic Tool Company, Chicago, Ill., is a universal coupler made of tough bronze which cannot corrode, and which, it is claimed, makes an absolutely tight joint. As can be seen from the illustration, neither half of the coupler is male or female,

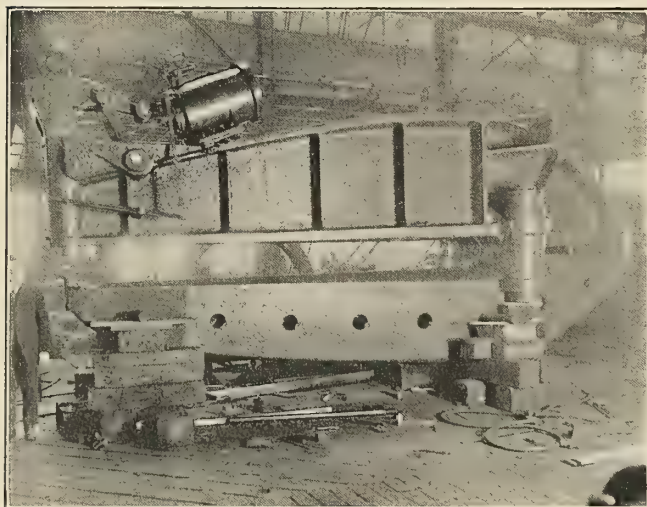
but a combination of both, so that any size of hose can be coupled to any other size of hose, whether it be larger or smaller. The gaskets are made of pure rubber, and are so



arranged that they cannot blow or fall out, so that no time will be lost in looking for washers. The couplers are manufactured for male or female thread pipe size, as well as for hose from $\frac{3}{8}$ inch to 1 inch.

Hanna Compression Yoke Riveter

The Vulcan Engineering Sales Company, Chicago and New York, who control the entire product of the Hanna Engineering Works, recently furnished the General Electric Company, Pittsfield, Mass., with a Hanna type compression yoke riveter, weighing 56,000 pounds, for the riveting of transformer cases. This riveter has a reach of 168 inches, a gap of 12 inches, and exerts a pressure of 100 tons on the rivet with 100 pounds air

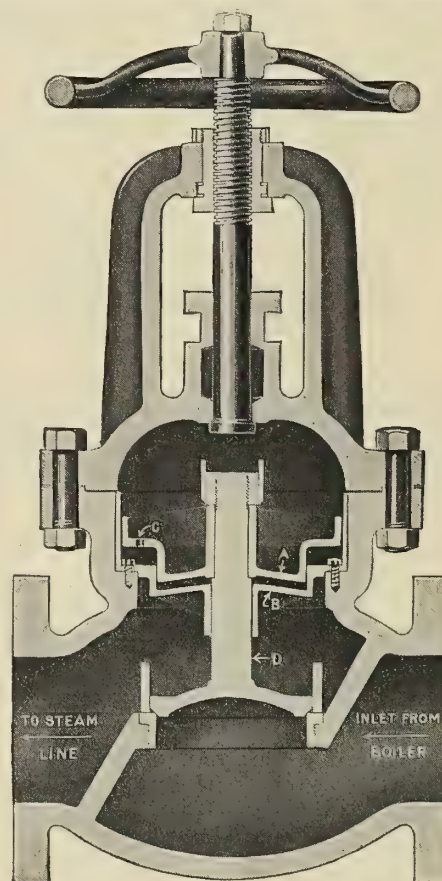


pressure in the cylinder. The size of the cylinder is 18 inches diameter, 22 inches stroke, and the movement of the plunger and upper die is $5\frac{3}{4}$ inches. Of this distance $4\frac{3}{4}$ inches is traversed during the first 11 inches of the stroke of the air cylinder piston, and the last 1 inch (under approximately uniform pressure and movement) during the last 11 inches of the stroke of the air cylinder piston. This last 1 inch of uniform travel and pressure, it is claimed, gives the machine all the advantages of the hydraulic riveter with the added advantage of low air pressure for actuating the mechanism instead of hydraulic pressure, usually from 1,000 to 1,500 pounds to the square inch. The machine also has the advan-

tage of exhausting into the atmosphere without special provision of exhaust pipe, as is required with the hydraulic machine. These advantages will be readily appreciated by those familiar with the objectionable operating features incident to excessive hydraulic pressure and the difficulty of taking care of the discharge water. But its marked advantage over the hydraulic riveter is in the fact that the air gap is closed at high speed (under the toggle lever action), while the rivet is headed and finished at very slow speed (under the plain lever action), thus giving the plates ample time to adjust themselves and the metal in the rivet to flow sufficiently to fill thoroughly the hole and for the head to set. The fact that the entire travel of the plunger and upper dies in a hydraulic riveter is at a uniform speed necessitates the conclusion that a speed which is economical for closing the air gap is too fast to finish and head the rivet, if the best possible results are obtained.

Anderson Double-Cushioned Non-Return Valves

The Golden-Anderson Valve Specialty Company, Pittsburg, Pa., has on the market a double cushioned automatic non-return valve of both the globe and angle type. The construction of the valve is apparent from the sectional view shown herewith. When the hand-wheel is run down into the closed



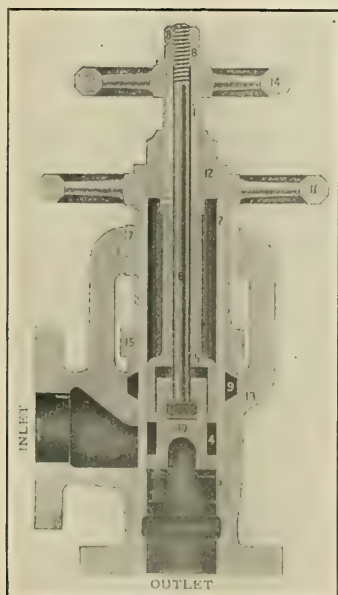
position the valve is shut like any globe valve. The hand-wheel stem, however, merely bears against the valve stem and is not attached to it, so when raised to the open position the valve disk is free to rise and fall under the action of the steam. To the upper end of the valve stem is attached a piston that creates a dash chamber in the top of the valve body above the liner. Through this liner the valve stem passes loosely enough to permit entrance of full pressure to the cushion chamber above the liner and through a small hole in the piston to the chamber above. Steam flowing into the header raises the valve and holds it open so long as the flow continues. If the flow ceases quietly, as when the fires are

drawn, the valve settles on to its seat and remains closed against the header pressure. Sudden reversal of steam flow in case of rupture or other accident in the boiler tends to close the valve instantly. This it would do with destructive force were it not for the dash-pot and the cushioning device above the liner. The Corliss dash-pot method of cushioning is employed, occupying the full area of the upper portion of the body of the valve, thus insuring a positive cushion in the opening and closing of the valves and perfect alinement with the seat at all times, regardless of position. The hole through the dash piston permits rapid escape of steam to the chamber above and a quick drop of the valve to within about $\frac{1}{8}$ inch of its seat, when the closer fitting secondary cushion comes into action as the lower portion of the piston enters the corresponding depression in the liner, forming a chamber from which the pressure can escape only gradually. The full boiler pressure is always above the dash-pot and the valve will close, at the same time being cushioned in the operation.

These valves are made extra heavy for a working pressure of 350 pounds per square inch. When placed in the boiler outlet the valve will permit the passage of steam to the header or main as required in regular service, but will close quickly against the reversal of the flow of steam. In case of accident to the boiler this valve will isolate the disabled unit from the rest of the battery, thereby not only reducing the destructive results of the accident, but also confining the damage to this one boiler, and avoiding oftentimes the necessity for any interruption in the operation of the rest of the boilers in the battery.

The Eynon-Evans Blow-off Valve

The Eynon-Evans Manufacturing Company, Philadelphia, Pa., has on the market a heavy flanged, nickel blow-off valve, built for the heaviest service. The illustration shows the valve in a closed position. The inlet is connected to the blow-off pipe from the boiler. The body and yoke of the valve



are of iron cast in one piece. A special nickel ring, 3, is secured in the iron body, the inside diameter of which is the same as the inside diameter of the bronze shield, 2, forming a continuous surface for the reception of the packing, 4. This packing is so placed in the ring and shield that it prevents leakage from the inlet to the outlet and around the bronze stem, and can be adjusted or compressed to the desired density while the valve is in service. The upper hand-wheel withdraws the pistons with the packing from the nickel ring into the bronze

shield. The shield itself is operated by the lower hand-wheel. The principle involved is that of absolutely protecting the packing inside the shield before the grit, scale and other destructive blow-off products are permitted to pass through the valve from the boiler. The lower end of the shield also acts as a valve, which permits the removal and inspection of the packing, while the blow-off valve is in service with full boiler pressure.

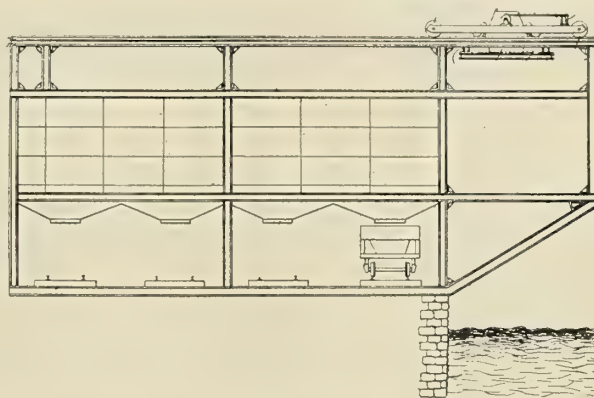
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,055,788. BARGE-UNLOADING APPARATUS. EDWIN R. ORBIN, OF DUQUESNE, PA.

Claim 1.—A barge-unloading apparatus embodying a framework, a crane movable upon said framework, a discharge spout invertibly sup-



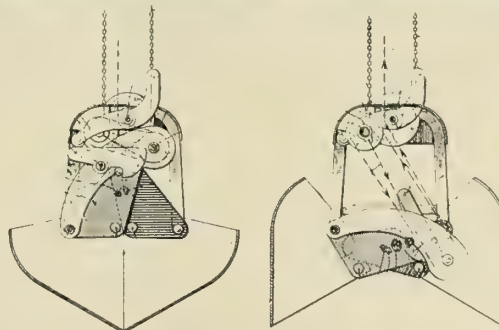
ported by said crane, an elevator suspended from said spout and adapted to be lowered to receive a barge and means for raising and lowering said elevator to and from said spout. Nine claims.

1,055,371. DREDGE. JAMES M. THORP AND VERNOR E. THORP, OF ALAMEDA, CAL.

Claim 1.—In a dredge, the combination of a swinging frame, means to swing the frame, and intermediate connecting mechanism adapted to reduce the rate of motion of the frame during its forward movement, said intermediate mechanism consisting of the arm pivoted to the barge and connected with swinging means and the arm connecting the arm with the swinging frame. Ten claims.

1,058,028. CLAM-SHELL BUCKET. CHARLES BERGHOFER, OF MILWAUKEE, WIS.

Claim 1.—A bucket comprising a pair of bucket sections, a hanger frame, a pivotal connection between the hanger frame and each of the bucket sections, arms extending from the bucket sections adapted to



overlap each other intermediate of their fulcrum points, the arms being provided with angularly disposed slots, a rod connection engageable with the arm slots, a bail connecting the arms of one of the bucket sections, a grip-lever having one end fulcrumed to the hanger frame, a snatch-dog carried by the lever for engagement with the bail, a cable in connection with the free end of the grip-lever, whereby the same is actuated, and a tripping mechanism for the snatch-dog. Six claims.

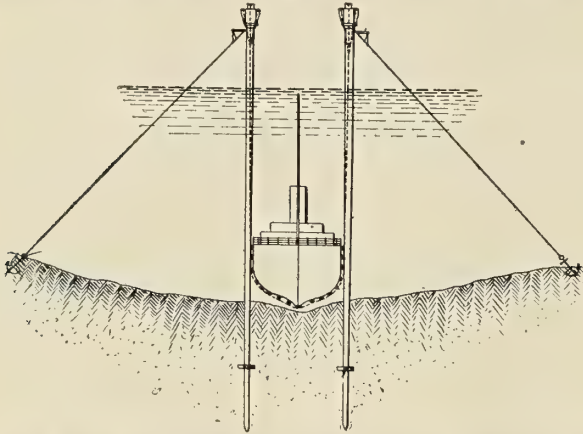
1,058,539. GRAB-BUCKET. WILLIAM H. BOTTEN, OF CLEVELAND, OHIO, ASSIGNOR TO THE OWEN BUCKET COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

Claim 1.—In a grab-bucket, a pair of pivoted bucket jaws, a bucket head to which the jaws are connected, a counterweight at the pivotal axis of the jaws, and means for opening and closing the jaws, said

counterweight comprising a main portion permanently fastened in position and having the bucket closing means connected to the top thereof, and a plurality of jackets removably secured to said main portion and extending along the same substantially sides of the attachment to the bucket closing means. Five claims.

1,061,218. MEANS FOR RAISING SUNKEN VESSELS. JOHN ARBUCKLE, OF NEW YORK, N. Y.; CHRISTINA ARBUCKLE AND CHARLES A. JAMISON, ADMINISTRATORS OF SAID JOHN ARBUCKLE, DECEASED.

Claim 1.—In apparatus the combination of a series of piles, lifting means supported upon said piles and flexible connections passing over



the top of said lifting means and adapted to exert a central or longitudinal thrust on said lifting means and connected to the vessel. Twelve claims.

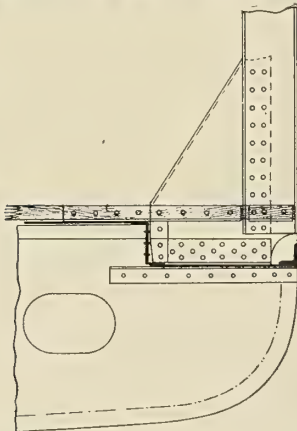
1,061,088. RUDDERS FOR THE SUBMERSION AND THE NAVIGATION OF SUBMARINE VESSELS UNDER WATER. CESARE LAURENTI, OF SPEZIA, ITALY, ASSIGNOR TO FIAT-SAN GIORGIO, SOCIETA ANONIMA, OF SPEZIA, ITALY.

Claim 1.—A submergible vessel, comprising a hull and a depth controlling rudder having a fixed angle of inclination less than a right angle from a horizontal plane, said rudder being adapted to be drawn within or protruded out of said hull. Seventeen claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

2,907. AN IMPROVEMENT IN THE CONSTRUCTION OF SHIPS. J. CARMICHAEL, OF EAGLESCLIFFE, R. S. O., DURHAM.

The improved construction of ships is characterized by the fact that the tank marginal plate, which is placed in a horizontal position, is so connected with the tank top as to form a recess along the ship's side



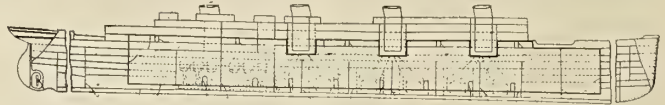
adapted to accommodate a gutter or bilge waterway or drainage and for securing the bottom edge of the gusset plate or Isherwood frame with or without a double angle bar connection between the gusset plate and tank top.

2,388. SHIPS' DAVITS. M. TEERLING OF LANDSTRAAT, DELFZYL, HOLLAND.

This invention relates to a ship's davit in which the jibs have their lower ends mounted on wheels or runners and running in constant rolling contact upon quadrant bars fixed in position to form suitable tracks for the runners or wheels. The jibs are supported and guided in their jiblike movement by working in slots in the girder bars of side frames as directed by the tackle provided for the purpose, the davit tackle being operated from one drum shaft and the boat tackle from another, the former passing over a pulley on the end of a stanchion projected from each of the jibs of the davits and the latter being adjustable in its line of pull on the jib by sliding bars, adapted to be projected as required from the girder beams of the side frames. The arrangement enables the apparatus to work by gravity derived from the load in the boat and the boat to be swung out clear of the ship's side.

10,468. IMPROVEMENTS IN SHIPS. A. E. MUIR, OF 10 GILLSIDE GROVE, SUNDERLAND.

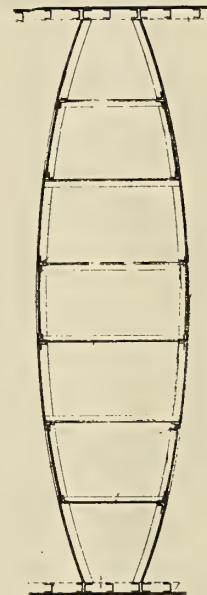
In order to provide a ship that will be as far as practicable unsinkable, transverse bulkheads are provided at suitable intervals for dividing the vessel into a number of separate watertight compartments, and there is also provided a central longitudinal buoyancy chamber of such dimensions and capacity that, in the event of the vessel being holed or damaged throughout a considerable portion of its length and a correspondingly large number of watertight compartments being rendered ineffective, the vessel will, owing to said chamber, still have sufficient buoyancy to remain afloat. The sides of the chamber extend vertically from the bottom of the vessel to any suitable height, but the bottom of the chamber is



arranged some distance above the inner bottom or tank top so as to constitute two double bottoms to the chamber for the purpose of rendering it invulnerable in the event of the double bottom of the vessel being holed. Passages are provided through the chamber in the engine rooms, boiler rooms, etc., for the purpose of giving access from one side of the chamber to the other, and in the event of any of the compartments being holed for allowing the water entering the same to flow to the other side of the chamber to preserve the trim of the vessel.

10,867. STRUCTURE OF STEAM SHIPS AND OTHER VESSELS. R. OSWALD, OF RIVERVIEW, BEACONSFIELD ROAD, BLACK HEATH, LONDON.

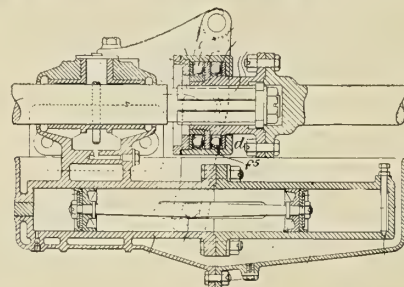
The sides of a ship have arranged between them a double bulkhead, the two parts of which are horizontally arranged, with their concave faces towards each other and are strengthened by angle bars and by



cross-bars or girders and vertical angle bars. Doorways are formed in the bulkhead. Instead of being outwardly curved, the bulkheads may be inwardly curved and nearer together at the center than at the ends, or instead of being curved they may be of triangular formation. The vessel may have two skins between which a space is left so that should the outer or main skin be fractured the vessel will remain watertight by means of the inner skin.

19,169. DRIVING GEAR FOR BOATS. DAIMLER-MOTOREN-GESELLSCHAFT, OF FABRIKSTRASSE, UNTERTURKHEIM, GERMANY.

In driving gear for boats the propeller shaft is mounted so as to be axially movable in relation to the driving shaft, and a cataract regulator,



or fluid or liquid brake or dash-pot device, is inserted between the two shafts for the purpose of reducing or nullifying shocks. The propeller shaft is connected with a lever mechanism which transmits the axial movements of the propeller shaft to one part of the cataract regulator device which has a regulatable inlet and outlet port and is arranged in a trough or container from which it sucks, or to which it delivers, the fluid or liquid used in the device.